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Transportation-Related Land Use Strategies to Minimize Motor Vehicle Emissions:

An Indirect Source Research Study

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
AIR RESOURCES BOARD
Research Division

Transportation-Related Land Use Strategies to Minimize Motor Vehicle Emissions: An Indirect Source Research Study

Final Report

Contract No. 92-348

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ABSTRACT

This research project was undertaken to obtain a better understanding of the potential quantitative benefits of land use planning and development in conjunction with multimodal transportation facilities that provide convenient alternatives to personal vehicle travel. The results of this research are intended to provide information to local governments, air districts, planning organizations, designers, builders and other interested parties. The information may be used in developing land use-related programs that can increase the rate of walking, bicycling and transit use. Such strategies can reduce dependence on automobile travel while ensuring personal mobility and providing cleaner air.

The report suggests community-level performance goals that can reasonably be attained in urban, suburban and rural/exurban communities by implementing packages of transportation-related land use strategies in coordination with a multimodal transportation system. The performance goals are listed in terms of average annual vehicle travel per household and related vehicular emissions. The report recommends eight packages of transportation-related land use strategies appropriate for urban, suburban, and rural/exurban communities. It also provides detailed descriptions of specific strategy characteristics for each type of community, including suggested development densities and mixtures and configurations of land uses. In addition, implementation mechanisms for local governments are listed and examples provided of existing programs.

The performance goals and recommended strategy packages are based primarily on data gathered in a recent study of travel behavior, land use and transportation characteristics of twenty-eight sample communities in California. In addition, an extensive review of the literature, as well as travel survey data from communities in California, Oregon and Canada are used. An extensive annotated bibliography and summary of references on the topic are also included.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

List of Tables (continued)

Page

1. SUMMARY AND CONCLUSIONS

A goal of the California Air Resources Board (ARB) is to reduce vehicular emissions in an effort to meet the State and Federal Clean Air Act requirements. One area of research that can be performed is the quantification of travel and emissions impacts of transportation-related land use strategies.

The need to travel and the method of travel from an origin to a destination is influenced by land use patterns and the availability of transportation services. In this research project, transportation-related land use strategies have been identified that can be implemented to improve the efficiency and facilitate the use of transit, pedestrian, and other alternatives to single-occupant motor vehicles. As a result, these strategies would reduce, or slow the growth of, vehicle trips (VT), vehicle miles traveled (VMT) and pollutant emissions. The strategies examined in this study are intended to work in combination with other air quality programs designed to decrease reliance on driving, reduce vehicular emissions, and control of stationary sources of pollution. Transportation-related land use strategies are not expected to attain air quality standards by themselves, but they can be an important part of the effort to improve air quality. Not included in this research project are strategies that are primarily transportation incentives and disincentives that do not include a land-use-related component. Examples of strategies not included in this study are: transportation demand management (TDM) strategies; small, incremental increases in transit service; increased gasoline costs or other pricing programs; and low or zero-emission vehicles.

The places people travel, such as major shopping centers, universities, and employment centers (for example), are referred to as "indirect sources" by air quality specialists because they attract vehicle travel. Numerous vehicle trips to and from such destinations produce emissions that can be quite significant when compared to pollutants emitted by typical stationary sources of air pollution, such as power plants, oil refineries, and manufacturing facilities. For this reason, the California Clean Air Act, adopted in 1988, required air districts to develop air quality attainment plans that include a provision to develop a program to reduce emissions related to such "indirect sources." However, State law prohibits air districts from infringing on existing local government land use authority in controlling indirect source emissions. (Cal. Health and Safety Code Section 40716(b)).

The information contained in this report is advisory and intended to assist local governments in considering air quality criteria when making transportation and land use decisions. A primary goal of this project has been to provide information to local governments, air quality districts, developers, and other

interested parties on how land use planning can be used in conjunction with transportation systems to help improve air quality. The specific objectives of the research project were as follows:

- Provide a comprehensive review of the literature and existing databases as they pertain to the relationships among land use, transportation and air quality.
- Identify transportation-related land use strategies that are effective, realistic, and implementable for a given situation (e.g., type of community, air quality problem).
- Define levels of performance goals for urban, suburban, and rural (exurban) communities that local government air quality districts and others can use in determining the appropriate performance goal for their situation.
- Recommend appropriate combinations of strategies that could assist in reaching the performance goals.
- Describe implementation mechanisms that can be used to implement the transportation-related land use strategies identified within existing local government policy-making structures for land use decisions.

The results from this project will provide a better understanding of the relationships among land use, transportation and air quality, and will aid the ARB and local air districts in working with communities in their efforts to help meet air quality attainment goals.

1.1 KEY FINDINGS OF THE STUDY

The most significant finding of this research study is that it is possible to develop recommendations for combinations of transportation-related land use strategies that are based on quantified data available from actual communities in California and that are applied separately to urban, suburban, and exurban communities. The recommended strategies are an example of ways that land use planning and development can be implemented in conjunction with transportation systems to reduce the amount of, or growth in, vehicle travel per household and resulting motor vehicle emissions. The availability of detailed travel and land use data for a sample of communities in California allowed the recommendations to have a quantitative basis. If data were made available for a larger number of communities in California, the strategy recommendations could be even further refined.

Throughout this research study, a number of key findings emerged. The most significant of these are summarized below.

Literature Review

Much of the literature on transportation-related land use strategies does not contain analyses of modeled or empirical data. A significant finding of this research study was the identification of those literature sources with the most complete and defensible quantification of impacts. Quantifiable effectiveness data obtained from the literature review was summarized in a matrix. Together with a detailed annotated bibliography, this format facilitated the use of the literature review in the development of the performance goals and strategy recommendations. It is difficult to quantify reductions in vehicle use and emissions from individual transportation-related land use strategies applied separately or on a site-specific basis, as opposed to community-wide. However, this study found that comprehensive packages of strategies, applied on a community-wide level, can be a fairly reliable method for achieving quantifiable reductions in emissions from vehicle use.

Case Study Community Data

Communities located in California and outside of California were used as case studies for this research study. The California communities were examined to determine how travel and land use characteristics vary within the state. Travel and land use data from Portland, Oregon and some Canadian cities were examined to provide a basis of comparison for the characteristics found in California and to serve as a reasonableness check for our recommendations. These cities serve as potential models of improvement for California communities because they are similar in age and development patterns, yet they have maintained greater transit use and lower levels of household vehicle use. Suburban residents of Canadian cities average roughly half as much VMT per household as do suburban residents of the sample California communities. Summaries for each of the case study communities are provided in Chapter 4 of this report.

Holtzclaw Study

A significant resource used for this research study was a detailed examination of travel data and transportation and land use characteristics from California communities conducted by John Holtzclaw. This study, *Using Residential Patterns and Transit to Decrease Auto Dependence and Costs*, was prepared for the Natural Resources Defense Council in June 1994. The data from this study provided the basis for developing the performance goals and defining specific characteristics related to the density, intensity, and mix of development needed to support a multimodal transportation system and reduce driving.

Performance Goals

A significant achievement of this project was the identification of community-level performance goals related to vehicle use per household. The strategy for developing the goals is described in Chapter 5 and summarized in Table 1-1. Using primarily the data from the case studies, three ranges of performance goals for urban and suburban areas and two ranges of performance goals for exurban areas were specified. Based on its community type, a local jurisdiction could select a performance goal level that represented the amount of reduction in per-household vehicle travel and associated vehicle emissions desired from transportation-related land use strategies. The performance goals are described in more detail in Chapter 5, and a summary is provided in Table 1-2.

Recommended Strategies

After reviewing the literature, the case studies, and the Holtzclaw study, a list of recommended strategies was developed. Not all strategies are recommended for each community type or performance goal level, as described for the strategy packages. Many of the elements of the recommended strategies already exist in a number of communities in California. A brief description of each of the recommended strategies is provided below.

Provide Pedestrian Facilities. This strategy emphasizes pedestrian accessibility through the provision of convenient and direct pedestrian and bicycle facilities including sidewalks, crosswalks, and protection from fast vehicular traffic.

Increase Density Near Transit Corridors. This strategy consists of efforts to intensify land uses within walking distance of a transit corridor or surface transit route. This strategy is typically characterized by new development, infill and redevelopment.

Increase Density Near Transit Stations. This strategy encourages efforts to intensify land uses around existing or planned high-capacity transit stations (bus and/or rail). It includes new development, infill and redevelopment, and incorporates direct and convenient pedestrian linkages.

Encourage Mixed-Use Development. This strategy encourages the location of compatible land uses within walking distance of each other. Mixed-use development typically results in a higher level of walking, as well as a greater potential for transit use, compared to single-use development.

Encourage Infill and Densification. This strategy includes the infill, redevelopment and reuse of vacant and underutilized parcels within an already developed area. Implementation of this strategy tends to encourage walking and higher rates of transit use, and also increases the efficiency of transit systems.

(continued)

Table 1-1
DEVELOPMENT OF PERFORMANCE GOALS

SAMPLE COMMUNITY	REGIONAL LOCATION	VMT PER HOUSEHOLD PER YEAR	PERFORMANCE GOALS: AVERAGE VMT PER HOUSEHOLD PER YEAR
URBAN COMMUNITIES			
northeast San Francisco	San Francisco (SF) Bay Area	5,500	**URBAN LEVEL 1 <10,000**
central Sacramento	Sacramento	10,100	**URBAN LEVEL 2 10,000 to 13,000**
San Francisco (total)	SF Bay Area	11,300	
Central Berkeley	SF Bay Area	12,500	
southwest Beverly Hills	Los Angeles	13,000	
Rockridge	SF Bay Area	14,300	**URBAN LEVEL 3 13,001 to 16,000**
southern Santa Monica	Los Angeles	14,700	
southern Long Beach	Los Angeles	15,300	
Uptown San Diego	San Diego	15,500	
SUBURBAN COMMUNITIES			
Alameda	SF Bay Area	17,000	**SUBURBAN LEVEL 1 <20,000**
south central Pasadena	Los Angeles	17,300	
Daly City	SF Bay Area	19,300	
central Downey	Los Angeles	21,400	**SUBURBAN LEVEL 2 20,000 to 22,000**
Alhambra	Los Angeles	21,700	
Escondido	San Diego	21,700	
Walnut Creek	SF Bay Area	22,300	**SUBURBAN LEVEL 3 22,001 to 25,000**
Lafayette	SF Bay Area	22,300	
Clairemont	San Diego	22,700	
northern Riverside	Los Angeles	23,700	
EXURBAN COMMUNITIES			
(No case study communities available)			**EXURBAN LEVEL 1 <28,000**
Morgan Hill	SF Bay Area	28,400	**EXURBAN LEVEL 2 28,000 to 30,000**

Source: John Holtzclaw, *Using Residential Patterns and Transit to Decrease Auto Dependence and Costs*, June 1994. Grouped and annotated by consultant team and ARB staff.

Table 1-2
PERFORMANCE GOALS

	VEHICLE TRIPS[1]	VMT[2]	MODE SHARE OF PERSON TRIPS[3]		EMISSIONS[6]
			AUTO DRIVER[4]	OTHER[5]	
URBAN COMMUNITIES					
Level 1	<1,600	<10,000	40%	60%	ROG: <31 CO : <348 NO: <27
Level 2	1,600 to 2,100	10,000 to 13,000	45%	55%	ROG: 31-40 CO: 348-455 NOx: 27-35
Level 3	2,101 to 2,600	13,001 to 16,000	55%	45%	ROG: 40-50 CO: 455-562 NOx: 35-43
SUBURBAN COMMUNITIES					
Level 1	<3,200	<20,000	60%	40%	ROG: <62 CO: <696 NOx: <54
Level 2	3,200 to 3,500	20,000 to 22,000	65%	35%	ROG: 62-68 CO: 696-763 NOx: 54-59
Level 3	3,501 to 4,000	22,001 to 25,000	70%	30%	ROG: 68-77 CO: 763-870 NOx: 59-67
EXURBAN COMMUNITIES					
Level 1	<4,500	<28,000	65%	35%	ROG: <87 CO: <977 NOx: <76
Level 2	4,500 to 4,800	28,000 to 30,000	70%	30%	ROG: 87-93 CO: 977-1044 NOx: 76-81

Notes:
1. Per household per year, on average
2. Vehicle miles traveled per household per year, on average
3. The percent of trips made by individuals by a given mode of travel
4. Auto Drivers include single occupant vehicles and drivers of carpools and vanpools (40% means that for 100 person trips there are 40 vehicles on the road)
5. "Other" includes all non-motorized forms of transportation, transit riders, and passengers of car/vanpools
6. Average pounds per household per year total emissions from light and medium duty vehicles and motorcycles (See Appendix H for methodology). (ROG - Reactive Organic Gases; CO - Carbon Monoxide; NOx - Oxides of Nitrogen)

- **Develop Concentrated Activity Centers**. This strategy clusters higher-density development appropriately into concentrated nodes to provide more convenient access to transit as well as increased opportunities for non-motorized travel.

- **Strengthen Downtowns**. Downtowns, also referred to as central business districts, are a special kind of Concentrated Activity Center. A strong downtown serves as a commercial, employment and cultural center which can encourage pedestrian travel within the area and also provides an important focal point for an area-wide transit system.

- **Develop Interconnected Street Network**. This strategy provides more direct routes for motor vehicles as well as pedestrians and bicycles. It reduces barriers created by wide arterial streets with fast-moving traffic and infrequent intersections while maintaining travel time for vehicles, even at somewhat lower speeds. Slower vehicular speeds help create a safer and more appealing environment for pedestrians and bicyclists.

- **Provide Strategic Parking Facilities**. It is possible to provide a lower amount of parking supply in areas with increased rates of transit use and walking/bicycling occurring as a result of the implementation of the strategies listed above. Less surface parking area reduces the distances between different land uses, which allows them to be more easily accessed by walking and transit use. Required parking supply should vary by land use type, proximity to transit service and accessibility to pedestrian and bicycle travel.

Description of Strategy Packages

As mentioned previously, one of the most significant findings of this study was that packages of transportation-related land use strategies for each of the community types may significantly reduce vehicle travel per household. For a local jurisdiction to determine which strategy package to pursue, the jurisdiction may identify its community type, determine current conditions, and select the performance goal that best meets its needs. The selection of a performance goal will be based on the amount of multimodal travel and air quality improvement desired for the community. The locality would then select an appropriate package of recommended strategies for the selected goal. Those strategies that have already been implemented in the jurisdiction can be determined and the remaining items would become the targeted strategies.

The recommended strategy packages, including specific details on density, mixture of uses, and proximity to transit, are provided in Chapter 6 of this report. These recommendations were based on the Holtzclaw study, the literature review, information made available by the Building Industry Association on the building types feasible at various densities, and the expertise of the consultants, Advisory Committee Members, and ARB staff.

Implementation Mechanisms

The study developed guidance on available mechanisms for implementing the recommended strategies. Descriptions of the implementation mechanisms are provided in Chapter 7 of this report and are organized in the following topic areas:

- policies;
- policy documents;
- administrative actions;
- organizational tools;
- resource tools;
- problems/solutions; and
- monitoring methods.

Some methods of implementing the recommended strategies are already available to communtiies through existing institutions and organizations. Examples of locations that have implemented these mechanisms are also provided. Table 1-3 indicates which of the implementation mechanisms are appropriate for each of the recommended strategies.

Future Research

The JHK team, ARB staff, and Advisory Committee members have identified a number of areas, listed below, that would benefit from future research and study.

- Expand the number of case study communities (as in the Holtzclaw study) to add to the database.
- Collect data for exurban communities to serve as case studies.
- Implement demonstration projects for transportation-related land use strategies and track changes in travel behavior associated with them.
- Develop baseline data for local jurisdictions in California that are comparable to the performance goals suggested in this report.
- Develop level-of-service standards for pedestrians, bicycles, and transit similar to those for intersections and streets.
- Evaluate the impact of traffic level-of-service standards on development densities.
- Perform additional analyses to further isolate the causality of a number of factors that influence travel behavior: density, lifestyle, income, availability of modes, attitudes, etc.

Table 1-3
TOOLS THAT CAN BE USED TO IMPLEMENT RECOMMENDED STRATEGIES

IMPLEMENTATION TOOLS	PROVIDE PEDESTRIAN FACILITIES	INCREASE DENSITY NEAR TRANSIT CORRIDORS	INCREASE DENSITY NEAR TRANSIT STATIONS	ENCOURAGE MIXED-USE DEVELOPMENT	ENCOURAGE INFILL AND DENSIFICATION	DEVELOP CONCENTRATED ACTIVITY CENTERS	STRENGTHEN DOWNTOWNS	DEVELOP INTER-CONNECTED STREET NETWORK	PROVIDE STRATEGIC PARKING FACILITIES
Policies That Can Be Created or Changed									
Top Priority Policies									
1. Set densities		✓	✓			✓	✓		
2. Create mixed-use zones				✓		✓	✓		
3. Award density bonuses		✓	✓	✓		✓	✓		
4. Focus growth within urban areas		✓	✓		✓	✓	✓		
5. Revise street standards	✓	✓				✓		✓	
Other Policies									
6. Allow transfer of development rights		✓	✓		✓	✓	✓		
7. Reduce requirements for setbacks and lots		✓	✓		✓	✓			
8. Require pedestrian and transit access in site plans	✓					✓			
9. Require signs to be at pedestrian scale	✓					✓	✓		
10. Revise parking standards	✓	✓	✓	✓		✓			✓
Policy Documents in Which to Create or Change Policies									
Top Priority Documents									
1. General Plan	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Zoning Ordinance	✓	✓	✓	✓		✓	✓		✓
3. Subdivision Regulations	✓					✓		✓	
4. Design Guidelines	✓	✓	✓			✓	✓		
5. Master EIRs	✓	✓	✓	✓		✓	✓	✓	✓
Other Documents									
6. Specific Plans	✓	✓	✓	✓		✓	✓	✓	✓
7. Redevelopment Plans	✓	✓	✓	✓	✓		✓		
8. Trip Reduction Ordinance	✓								✓
9. Capital Improvement Program	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 1-3 *continued*
TOOLS THAT CAN BE USED TO IMPLEMENT STRATEGIES

IMPLEMENTATION TOOLS	PROVIDE PEDESTRIAN FACILITIES	INCREASE DENSITY NEAR TRANSIT CORRIDORS	INCREASE DENSITY NEAR TRANSIT STATIONS	ENCOURAGE MIXED-USE DEVELOPMENT	ENCOURAGE INFILL AND DENSIFICATION	DEVELOP CONCENTRATED ACTIVITY CENTERS	STRENGTHEN DOWNTOWNS	DEVELOP INTER-CONNECTED STREET NETWORK	PROVIDE STRATEGIC PARKING FACILITIES
Administrative Actions									
Top Priority Action									
1. Streamline permit process	✓	✓	✓	✓		✓	✓	✓	✓
Other Actions									
2. Negotiate development agreements	✓	✓	✓	✓		✓	✓	✓	✓
3. Modify fees and exactions	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Attract employers		✓	✓			✓	✓		
5. Establish enterprise zones			✓		✓		✓		
Organizational Tools									
1. Combine land use and transportation planning	✓	✓	✓	✓		✓	✓	✓	✓
2. Involve service providers	✓	✓	✓	✓	✓	✓	✓	✓	
3. Work with transit agency	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Involve business and community groups				✓	✓		✓		
5. Enter agreements with neighboring jurisdictions		✓	✓		✓	✓	✓	✓	
6. Establish a Joint Powers Authority	✓					✓			
7. Use the Congestion Management Agency	✓	✓	✓	✓					✓
Resource Tools									
1. ISTEA	✓	✓	✓			✓	✓	✓	
2. Housing and community development funds		✓	✓	✓	✓		✓		
3. Main Street Program	✓						✓		
4. Historic preservation tax credits							✓		
5. Motor vehicle registration fee surcharge funds	✓	✓	✓			✓	✓	✓	
6. Redevelopment Area	✓	✓	✓	✓	✓		✓		

Table 1-3 *continued*
TOOLS THAT CAN BE USED TO IMPLEMENT STRATEGIES

IMPLEMENTATION TOOLS	PROVIDE PEDESTRIAN FACILITIES	INCREASE DENSITY NEAR TRANSIT CORRIDORS	INCREASE DENSITY NEAR TRANSIT STATIONS	ENCOURAGE MIXED-USE DEVELOPMENT	ENCOURAGE INFILL AND DENSIFICATION	DEVELOP CONCENTRATED ACTIVITY CENTERS	STRENGTHEN DOWNTOWNS	DEVELOP INTER-CONNECTED STREET NETWORK	PROVIDE STRATEGIC PARKING FACILITIES
7. Public/private partnerships			✓	✓			✓		
8. Public and tax delinquent land		✓		✓	✓		✓		
9. Assessment districts	✓						✓		
10. Mello-Roos districts	✓					✓	✓		
11. General fund	✓	✓	✓	✓	✓	✓	✓	✓	
12. Bonds	✓		✓		✓	✓	✓		
Problems and Solutions									
1. Public opposition; Education and improvements	✓	✓	✓	✓	✓	✓		✓	✓
2. Capital reluctance; Education, guarantees, local funding	✓		✓	✓			✓	✓	✓
3. Uncertain market; Market studies and marketing	✓	✓	✓	✓	✓		✓	✓	✓
4. Developers building elsewhere; Multi-jurisdictional cooperation	✓								
Monitoring Methods									
1. Track new development projects in jurisdiction	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Track new development projects outside jurisdiction	✓								
3. Evaluate the capital improvements program	✓	✓	✓			✓	✓	✓	
4. Conduct ridership and path use surveys	✓	✓	✓	✓		✓	✓		

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- Examine relationships between parking use, parking supply, parking costs, and parking requirements.
- Examine the relationship between quality of life characteristics such as crime, income, and density.
- Collect land-use-specific vehicle trip generation rates in California and evaluate how they are impacted by factors such as density, mixture of uses, location within metropolitan areas, and transit availability.

1.2 HOW THE WORK WAS PERFORMED

The consultant team performed this study according to eight tasks defined by the ARB. These tasks are listed below and described in more detail in Chapter 2 of this report. More detailed information on the methodologies applied in this research effort is provided throughout this report.

- Task 1. Review of Literature
- Task 2. Identification of Potential Effects
- Task 3. Development and Description of Strategies
- Task 4. Assessment of Strategy Effectiveness
- Task 5. Specification of Performance Goals
- Task 6. Recommendation of Strategies
- Task 7. Identification of Implementation Mechanisms
- Task 8. Preparation of the Final Report

The ARB formed an Advisory Committee was to provide guidance throughout the study, review its progress at key points, assist in the selection of the transportation-related land use strategies, and review the analytical approach. Members of the Advisory Committee included representatives from air districts, public transit districts, metropolitan planning organizations, cities and counties, the building and retail industries and environmental organizations.

The first step in the study was the development of descriptions for the three community types: urban, suburban, and exurban/rural. Each of the community types is described according to the following characteristics: function, size, centrality, density and age. A summary of the characteristics for each of the community types is provided in Chapter 4.

An extensive review of the literature on transportation-related land use strategies was performed to identify studies that included quantitative evaluations of travel and emissions impacts. The identification of recently-available studies for use in this research project was an important aspect of this review because the effort to examine land use impacts on transportation behavior is a growing field.

Based on the review of the literature, eleven transportation-related land use strategies were identified as potentially effective at facilitating the provision and increased use of transit, bicycle, and pedestrian facilities, and thus reducing emissions from the use of motor vehicles. An important consideration in the identification of these strategies was the ability to potentially combine them for each of the community types. (The potential strategies are listed and described in more detail in Chapter 3.) Data used for evaluating the transportation-related land use strategies included information collected from an extensive literature review, case study evaluations of communities within California, and examples of cities outside of California that have historical land use development similar to California communities.

Based on the data collected for this study, three levels of performance goals were set for the urban and suburban community types and two levels for exurban areas. (Only two categories of performance goals were suggested for exurban areas because of the limited case study data available for this community type.) The performance goals are set at levels expressed as vehicle trips (VT) per household (HH) per year, vehicle miles traveled (VMT) per HH per year, and modal shares. For each performance goal level and area type, pollutant emissions that would result from the average VT and VMT per HH per year were estimated. The performance goals have been set as suggested targets that many communities can reasonably achieve with a concerted effort to implement transportation-related land use strategies. The goals were established based on travel characteristics found in actual communities in California and in similar communities outside of California.

Recommendations for transportation-related land use strategies have been developed that will assist local jurisdictions in attaining each of the performance goal levels. One package of recommended strategies is presented for each of the eight sets of performance goals (three levels each for urban and suburban jurisdictions, and two levels for exurban jurisdictions).

Mechanisms that can be used by local jurisdictions to implement each of the recommended strategies were identified and described. Many of the policies and programs recommended are compatible with the existing planning programs and goals in many of California's communities. The implementation of actions described not only help minimize motor vehicle emissions; they can also contribute to other local and regional priorities.

Finally, recommendations were developed for future research efforts. In conducting this study, a number of areas were identified where additional data may have been useful. Also, thought was given

to how the results of this research should be carried forward, such as developing a handbook that can be used by cities, counties, air districts, developer and building industry associations, and others.

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2. PROJECT SCOPE AND PURPOSE

2.1 PURPOSE OF THIS RESEARCH PROJECT

The need to travel and the method of travel from an origin to a destination is influenced by land use patterns and the availability of transportation services. For decades, development trends in California have been towards less dense land uses along transportation corridors away from city centers. This has led to longer trip lengths in some cases, the provision of fewer alternative modes of transportation (such as transit), and increased vehicle miles traveled (VMT) and resulting vehicle emissions. Although improved vehicle technology has provided automobiles that pollute less, the reduction in emissions is being offset by the growth in the number of vehicle trips made and the average length of these trips. Indirect source strategies have been included in several air quality improvement plans and programs to reduce emissions from motor vehicles to meet State and Federal Clean Air Act requirements.

In this research project, various transportation-related land use strategies have been examined to determine their potential effectiveness in altering travel behavior and reducing motor vehicle emissions. The amount of motor vehicle emissions reductions that could potentially result from implementing combinations of such strategies in urban, suburban, and exurban communities was estimated using available data. The strategies examined in this study are intended to work in combination with other air quality programs designed to decrease reliance on single-occupant vehicles, reduce vehicular emissions, and control stationary sources of pollution. Although transportation-related land use strategies are not expected to achieve attainment of ambient air quality standards by themselves, they can be an important part of the effort to improve air quality.

This project did not include an evaluation of strategies that are primarily transportation incentives and disincentives that do not include a land use-related component. Examples of strategies not evaluated include employer-based transportation demand management (TDM) strategies, small, incremental increases in transit service, and increased gasoline costs or other pricing programs.

In this research project, transportation-related land use strategies have been identified that can be implemented to reduce vehicle trips (VT), vehicle miles traveled (VMT) and pollutant emissions for many land uses typical in California. A primary goal of this project has been to provide information to local governments, air quality districts, developers, and other interested parties on how land use planning can be used to help improve air quality. State law prohibits air districts from infringing on existing local

government land use authority in controlling indirect source emissions. (Cal. Health and Safety Code Section 40716(b)). The information contained in this report is advisory and intended to assist local agencies in considering air quality criteria when making transportation and land use decisions.

2.2 OBJECTIVES

The specific objectives of the research project were as follows:

- Provide a comprehensive review of the literature and existing databases as they pertain to the relationships among land use, transportation and air quality.
- Identify transportation-related land use strategies that are effective, realistic, and implementable for a given situation (e.g., type of community, air quality problem).
- Define different levels of performance goals for urban, suburban, and rural (exurban) communities that local governments, air quality districts, and others can use in determining the appropriate performance goal for their situation.
- Recommend appropriate combinations of strategies that could assist in reaching the performance goals.
- Describe implementation mechanisms that can be used to implement the transportation-related land use strategies identified within existing local government policy-making structures for land use decisions.

The results from this project provide a better understanding of relationships among land use, transportation, and air quality, and will aid the California Air Resources Board (ARB) and local air districts in assisting communities in their efforts to achieve and maintain air quality attainment goals. These strategies may also help achieve additional goals such as creating more livable communities, providing housing, reducing infrastructure costs, reducing traffic congestion, preserving open space, and conserving natural resources.

An Advisory Committee was formed to provide guidance throughout the study, review the progress of the study at key points, assist in the selection of the case study sites, and review the analytical approach. Members of the Advisory Committee met over a two-year period and included representatives from air districts, metropolitan planning organizations, cities and counties, and the building and development industries.

2.3 SUMMARY OF TASK DESCRIPTIONS

A number of specific tasks were defined by the ARB to guide the research performed. A brief description of each of these tasks is provided below.

Task 1. Review of Literature. An extensive review of reported information, studies, and available data sources on the implementation of transportation-related land use strategies was conducted. The review included an inventory of available and applicable data on the relationships between land use, transportation systems, travel behavior, and reductions in vehicle use and pollutant emissions. The literature review focused on information available in California, the nation, and other countries, such as Canada, with land use patterns similar to California.

Task 2. Identification of Potential Effects. The information gathered in the literature review was used to divide a selection of California communities into three categories of land use and transportation characteristics for each of the three community types: urban, suburban, and exurban.

Task 3. Development and Description of Strategies. Based on the literature review and input from ARB staff and the Advisory Committee, transportation-related land use strategies were identified for examination in this research project. The focus of the strategy identification was on those transportation-related land use strategies that are community-wide in scope, and not site-specific in nature. Detailed descriptions of the characteristics of each of the strategies were also developed.

Task 4. Assessment of Strategy Effectiveness. The information developed in the previous tasks was used to identify estimates of effectiveness of various strategies. A preliminary identification was then performed to determine which strategies could most effectively achieve the levels of travel reduction for each of the three community types (urban, suburban and exurban).

Task 5. Specification of Performance Goals. To provide guidance on reasonable and achievable levels of travel and emissions reductions that can be attained through transportation-related land use strategies, performance goals were developed for each of the three community types. Levels of performance goals were developed to be applicable to the general characteristics of each type of community and to reflect the specific conditions in California.

Task 6. Recommendation of Strategies. Combinations of transportation-related land use strategies were identified that could be implemented to achieve the different levels of performance goals in each community type. Descriptions were presented in matrix form.

Task 7. Identification of Implementation Mechanisms. Mechanisms were identified that could be used to implement the recommended strategies. Organizational and institutional methods and processes suitable to implement the strategies were evaluated.

Task 8. Preparation of the Final Report. This Final Report documents the objectives of the research project, the procedures used for collecting and analyzing data, and the major results of the research were prepared according to the format specified by ARB.

Each of the tasks described have been successfully completed for this research project and the work performed is summarized in this Final Report. Figure 2-1 illustrates the organization of this report and how the results presented here can be used by local governments and other agencies or organizations.

(j/31009/final/CHAP2.FIN)

Key Steps in Applying the Study Findings:

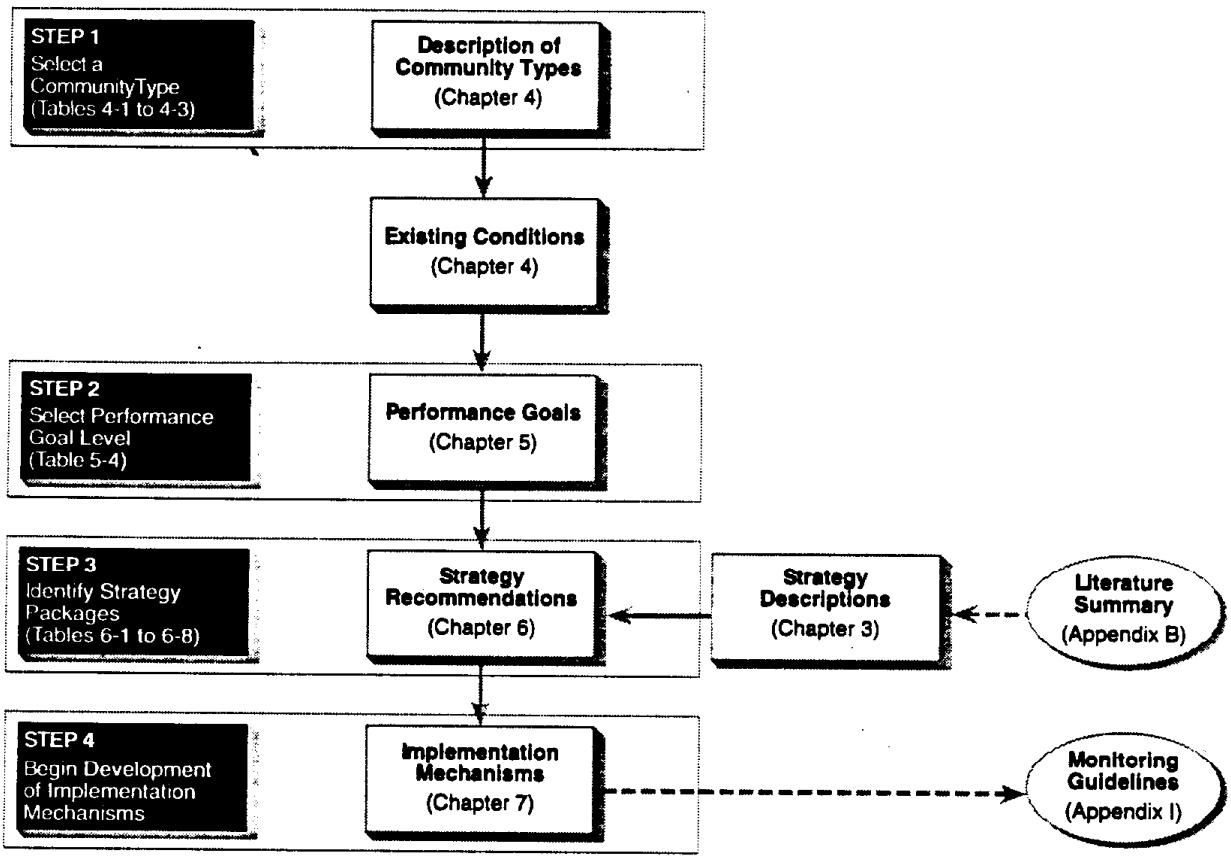

Figure 2-1
How to Use the Study Findings

3. TRANSPORTATION-RELATED LAND USE STRATEGIES

An important component of this research project was the identification of transportation-related land use strategies that could potentially impact travel behavior and reduce resulting motor vehicle emissions. A literature review was conducted to assist in the identification of strategies. The transportation-related land use strategies to be examined in this project were then selected and described. Based on the quantitative information contained in the literature review, preliminary estimates of individual strategy effectiveness were developed.

3.1 LITERATURE REVIEW

To gain an understanding of the impact of land use strategies on travel behavior, an extensive review of literature documenting local, national and international research was performed. The focus of this review was on literature that quantified the impacts of transportation-related land use strategies. There are many additional sources discussing the benefits of various land use strategies, but that do not support the discussion with empirical or modeled data. Those sources are not summarized in detail in this research project.

An important function of the literature review was to provide information on land use and transportation characteristics that have been effective in creating and supporting successful public transit systems and pedestrian-accessible communities. The use of this information to identify recommended strategy "packages" and their characteristics is described in Chapter 6 of this report.

The main points of the literature reviewed are highlighted in Section 3.4, organized by types of land use strategies appearing in the literature. A summary table of the quantifiable findings, and an annotated bibliography of the reports and articles reviewed, are provided in Appendix B.

3.2 SELECTION OF POTENTIAL STRATEGIES

The JHK Team, in consultation with ARB staff and with input from the Advisory Committee, developed a set of eleven transportation-related land use strategies for detailed analysis in this research project. The strategies selected all have the potential to reduce vehicle travel to indirect sources and the associated emissions, and entail actions that are within the usual scope of power of local jurisdictions in

California (cities and counties). As mentioned previously, the focus of the strategy selection was on those that are community-wide in scope, rather than those that are site specific.

An initial set of strategies was proposed for study by the JHK Team at the outset of the project. This initial listing included transportation-related land use strategies that, based on the experience of ARB staff and JHK team members, had a realistic chance of reducing vehicle trips (VT), vehicle miles traveled (VMT), and increasing the ratio of person trips to vehicle trips in California if implemented in coordination with a multi-modal transportation system. Strategies focused solely on expanding transportation facilities, such as the addition of single transit routes, were not included in the scope of this research project. The importance of the provision of transportation services was incorporated into this research project by describing the specific transportation services that need to be provided for an effective impact on travel behavior for each land use strategy.

The literature review conducted for this research project was used to further define specific strategies. An effort was made to include all types of land use strategies currently being proposed with some frequency to relieve transportation and air quality problems. Overall, the strategies consisted of measures that make related land uses more mutually accessible by means other than the automobile.

A preliminary list of strategies was presented to the Advisory Committee. Discussions led to further revisions to the list of strategies, as well as the addition of "interconnected street networks" as a distinct strategy. The final list of potential transportation-related land use strategies considered in the study include:

- Transit-Oriented Design
- Density Near Transit Stations
- Density Near Transit Corridors
- Mixed-Use Development
- Infill and Densificaiton
- Concentrated Activity Centers
- Strong Downtowns
- Jobs/Housing Balance
- Pedestrian Facilities
- Interconnected Street Networks; and
- Strategic Parking Facilities.

In Chapter 6 of this report, the recommended strategies from this list are presented.

There is some overlap between strategy elements due to the fact that most of the strategies are packages of related elements. For example, in terms of physical design and land use policies, *Transit-Oriented Design* includes mixed-use development, increased density near transit, and provision of pedestrian facilities. *Mixed-Use Development* is an individual strategy that reaches full fruition in the enhancement or creation of *Concentrated Activity Centers*. Such overlap is appropriate for this study, since it is aimed at defining and evaluating land use strategies that can be implemented by the full range of local jurisdictions in California. Some communities have or will have rail transit stations surrounded by developable land; these communities might reasonably pursue *Transit-Oriented Design* (TOD). Other jurisdictions do not have frequent transit service, nor even a realistic prospect of obtaining it. These jurisdictions would not be able to implement TOD, but if they had large tracts of developing land, they could pursue a pedestrian-oriented development related to *Pedestrian Facilities*. Similarly, not all jurisdictions have significant downtown or suburban activity nodes that can be developed into *Concentrated Activity Centers*; nonetheless, they could still pursue *Mixed-Use Development* on a smaller scale throughout their community.

3.3 DESCRIPTIONS OF POTENTIAL STRATEGIES

Tables A-1 and A-2 in Appendix A characterize the potential strategies in considerable detail. Table A-1 indicates what collateral transportation services are necessary to ensure effective implementation of each strategy, and also indicates qualitatively the expected impact of each strategy on various transportation modes and two variables that critically affect air quality: vehicle miles of travel (VMT) and vehicle trips (VT). Table A-2 provides the expected, non-quantified air quality effects of each strategy. Table A-2 also lists limitations, implementation barriers, non-transportation benefits, and other issues relevant to each strategy.

In the following sections, definitions and descriptions of each of the eleven final potential strategies examined in this research project are provided. For consistency with recent ARB investigations, many of the definitions are derived directly from the ARB report *The Linkage Between Land Use and Air Quality* (1994), authored by Terry Parker, an Associate Air Pollution Specialist with ARB. The definitions specified for this research project draw out important elements of the strategies and illustrate how the strategies differ from and relate to one another. These definitions are used in the analysis of strategy effectiveness.

Potential Strategy #1: Transit-Oriented Design (TOD)

Transit-Oriented Design (TOD) is a deliberate alteration of post-World War II suburban patterns. It assumes a sizeable parcel of developing/redeveloping land (at least one-third of a mile in radius) centered on a current or planned major transit station. Parker defines TOD as a concept that incorporates an intentional orientation to transit and pedestrian travel, clusters services and other uses in a 'town center.' Like the POD (see below), TODs provide a range of housing densities and mix of land uses."[1] A TOD has been described as:

> A mixed-use community within an average of one-quarter mile walking distance of a transit [station] and core commercial area. The design, configuration, and mix of uses emphasize a pedestrian-oriented environment and reinforce the use of office, open space, and public uses within comfortable walking distance, making it convenient for residents and employees to travel by transit, bicycle or foot, as well as by car. [2]

Although autos are accommodated within TOD, a high level of auto facilities is incompatible with TOD. Also, while TOD is often considered a strategy for newly developing areas at the metropolitan periphery, it may be even more effectively implemented as redevelopment within an urban or suburban area.

As noted in the *Linkage* report, "[t]ransit-oriented development is receiving serious attention in California. Plans for a new development south of Sacramento, 'Laguna West,' attempt to cluster higher-density housing surrounding a neighborhood commercial and service center that is more convenient for walking, biking and transit. Similar projects have also been proposed in San Diego, the San Francisco Bay Area, and other parts of California."[3] Similar projects are also underway in the Washington D.C. area, Florida and New Jersey. However, no new project including all of the elements of TOD has been fully built and occupied.

Potential Strategy #2: Density Near Transit Stations

This strategy consists of efforts to intensify land uses around high-capacity rapid transit stations. Typically, it is characterized by infill and partial redevelopment rather than full implementation of a comprehensive, idealized TOD. Unlike TOD, mixed use is not a necessary element. This strategy consists of a more incremental program for making the best use of both the transit system and the limited land supply near major stations. Such a program has the following goals:

- promoting land uses that generate the most transit and pedestrian trips near stations;

- locating these uses in close proximity to transit station entrances; and
- providing higher density land development around stations.[4]

As noted in the *Linkage* report: "[l]and use decisions for the areas around transit corridors are critical due to the fixed nature of rail transit,"[5] the large capital cost represented by rail, and the limited amount of land within easy walking distance (one-third to one-quarter mile) of rail stations. In such a setting, land use "decisions need to be made with a long-term view, as they will last for many years to come."[6] The wrong land uses or site designs can "impede the development of subsequent, more transit-supportive projects in the future. Land use measures to support alternative travel modes and reduce automobile use are available on both the community (or metropolitan) and local (neighborhood) levels."[7] Adequate pedestrian facilities are an important component of this strategy.

Potential Strategy #3: Density Near Transit Corridors

This strategy consists of efforts to intensify land uses within walking distance of a transit corridor. A transit corridor is envisioned as a surface transit route (bus or perhaps streetcar) rather than a major multi-modal center as is typically found at a major rail station. As defined here, transit accessibility is less than at a rapid transit station or within an idealized TOD. In most other respects, this strategy is similar to the preceding strategy. Typically this strategy is characterized by infill and partial redevelopment rather than full implementation of a comprehensive, idealized TOD.

Potential Strategy #4: Mixed-Use Development

Mixed-use development fosters integration of "compatible land uses, such as shops, offices, and housing," and encourages them "to locate closer together and thus decreases travel distances between them. Mixed-use development, if properly designed and implemented, can reduce VMT and VT and can help increase transit ridership, especially during the off-peak (non-commute) periods. For example, a mixed-use area containing restaurants, a museum, a theater and retail stores has a greater potential to generate transit ridership than an area with retail stores alone."[8] Regardless of how persons arrive at such a center, they will be able to make many trips by walking once they arrive at such a mixed-use center; such trip linkage would not be possible in a single-purpose area. The addition of residential uses can further increase pedestrian tripmaking.

"Mid-day trips from work for lunch or to run errands can also be influenced by mixed-use strategies."[9] Employees already on-site can supplement the buying power of nearby residents, reducing

the minimum market area required for a given type of establishment to be profitable. As defined here this strategy is a cumulative set of project- and site-level measures that can be applied to both new development and redevelopment.

Potential Strategy #5: Infill and Densification

The *Linkage* report succinctly characterizes the potential of this strategy:

> The infill, redevelopment and reuse of vacant or underutilized parcels within existing urban areas can help to decrease vehicle traffic, reduce walking distances and support better transit systems. This strategy also has other benefits: lower infrastructure costs, more efficient delivery of services, increased economic viability of cities, and reduced conversion of agricultural land and open spaces to urban or suburban development...
>
> Infill and redevelopment that is located within walking distance of transit service has greater potential to shift travel away from personal vehicles. The design, quality, mixture and compatibility of residential and other types of infill projects are factors that must be carefully considered to enhance their acceptability to neighboring residents and businesses, especially in the case of higher-density infill and redevelopment projects.[10]

Potential Strategy #6: Concentrated Activity Centers

This strategy seeks to combine higher-density development appropriately into concentrated nodes to take advantage of transit and opportunities for pedestrian and nonmotorized travel.

> The locations of these nodes may be urban or suburban. If a variety of activities (such as shops and services, offices, other employment sites and residences) are clustered, they can become lively 'activity centers.' A network of such centers, or "nodes," can more easily be linked by a transit network to other similar centers and to the central business district.
>
> Activity centers served by transit located in suburban areas can also provide accessibility to transit service for surrounding residential areas. Activity centers or nodes are also referred to as 'Urban Villages' or 'Suburban Business Districts.'[11]

Potential Strategy #7: Strong Downtowns

Downtowns, also referred to as central business districts, are a special kind of *Concentrated Activity Center*. Some of the functions of downtowns can be summarized as follows:

> Strong central business districts that include substantial amounts of both employment and housing have historically had the best quality transit service and the highest rates of transit use. Transit use tends to be higher in downtown sites for many reasons, including: there are a concentrated number of land uses located within walking distance of transit stations (such as jobs, shops, public facilities and retail services), higher parking costs, greater traffic congestion, limited parking availability, and better access to transit at both trip ends.
>
> Central business districts of many major cities in the U.S. tend to have a number of high-rise buildings, with some restaurants, shops and other services, but little activity after business hours or on weekends.[12]
>
> Higher density housing in the downtown and nearby areas can contribute to safer and more lively central cities, and reduce the commute for those residents who live and work downtown.[13]

Residents of downtown also tend to use transit more often and for more purposes than other metropolitan residents because downtowns are generally focal points of the regional transit system.

Potential Strategy #8: Jobs/Housing Balance

Another strategy that was considered was *Jobs/Housing Balance*. This strategy is intended to encourage employers to locate in areas where there are significantly more residents than jobs and add housing development near employment centers. It was not possible to draw any definitive conclusions about the ability to increase emission reductions as a result of government policy interventions designed to affect the ratio of jobs per household within an given geographic area. Quantitative studies on this topic are limited, and the literature is contradictory in its conclusions. For example, a study by Cervero concludes that a "balance" in the jobs-to-household ratio is associated with a three- to five-percent increase in travel by walking, cycling, and transit.[14] However, research conducted by The Planning Institute concludes that such intervention does not produce any enforceable quantifiable travel-related benefits.[15] It should be recognized that jobs/housing ratio intervention as an emission reduction strategy is dependent upon factors that are often beyond the direct control of individual counties, regional planning agencies, and air districts. As such, this strategy has not been recommended in Chapter 6. One such factor is that jobs must be compatible with the skill-levels and income expectations of nearby residents.

Potential Strategy #9: Pedestrian Facilities

The provision of pedestrian facilities and the similar concept of Traditional Neighborhood Design (TND) represent a development strategy "that emphasizes pedestrian accessibility and the orientation of houses towards narrower, tree-lined, grid-pattern or [otherwise] integrated streets." It combines, on a relatively small, neighborhood scale, "mixed uses and integrated street patterns to create a land use pattern that makes it easier for residents to walk between their houses, jobs, and commercial services."[16]

An area that focuses on the provision of pedestrian facilities, as defined for this project, or TND:

> incorporates a small downtown, or 'town center,' within walking distance of homes, and generally has a higher overall density than in typical suburban neighborhoods. 'A majority of housing units are located within a five- to ten-minute walk of the town center, where commercial services and offices are concentrated.'[17] A larger number of townhouse and other multi-family units are provided to meet this objective of locating residences within one-quarter mile (walking distance) of the town center.
>
> Single-family houses are placed somewhat further out from the town center, on somewhat smaller (compared to standard suburban) lots, with front porches closer to the sidewalk and garages typically placed behind the houses, often along alleys. 'Granny flats,' or second units, are sometimes built above the garages.[18]

Table 3-1 compares the characteristics of pedestrian-oriented developments to conventional suburban development. It should be noted that these design features apply also to TODs (Strategy #1); a TOD town center, however, is dominated by a major transit station and intermodal transfer facility. Because of the relatively smaller scale and lack of high-capacity transit, the density of uses, especially employment uses, tends to be lower than in a TOD project.

Table 3-1
FEATURES OF TRADITIONAL NEIGHBORHOOD VS. CONVENTIONAL SUBURBAN DEVELOPMENT[19]

TRADITIONAL NEIGHBORHOOD DESIGN	STANDARD SUBURBAN DEVELOPMENT
• Integrated Streets	• Hierarchical Streets
• Narrower Streets	• Wide Streets
• On-Street Parking & Parking Structures	• Off Street Surface Parking Lots
• Shallower Setbacks	• Deeper Setbacks
• Shopping on Main St.	• Strips/Malls
• Mixture of Uses	• Single Uses
• Traffic Calming	• Auto Traffic Flow Optimized

Potential Strategy #10: Interconnected Street Networks

Regarding this strategy, the ARB *Linkage* report notes:

> During the past 20 years, the typical street circulation pattern in developing suburban areas has consisted of a hierarchy of local streets leading to collector streets, and then to major arterials that interconnect sections of a community to each other and to freeways.
>
> Collector and arterial streets, which often provide the only connections between different sections of suburban communities, tend to be quite wide to allow vehicles to travel faster. The typical suburban circulation pattern decreases the number of available routes between trip origin and destination points, and places many vehicles on major streets and at signaled intersections during peak hours....
>
> In contrast to the typical suburban street hierarchy, an integrated street pattern provides multiple routes to destinations, reducing the distances between two points. Overall vehicle travel times in integrated street patterns are comparable to the faster-moving arterials due to the shorter distances between various origin and destination points....
>
> Typically found in many older neighborhoods and small towns, integrated street networks have several advantages over typical suburban-style street patterns. They provide a number of route choices, more direct routes for pedestrians and bicyclists as well as cars, and they help to slow vehicle speeds. Slower vehicle speeds create a much safer and more interesting environment for pedestrians and bicyclists to share, and reduce noise impacts from vehicles.[20]

Traffic calming measures–street narrowing, vehicle diverters, pavement treatment to slow traffic–may be an important complement to interconnected streets to ensure that vehicle speeds are not high.

Potential Strategy #11: Strategic Parking Facilities

This strategy actually consists of two measures which may be developed independently or in conjunction with one another.

Parking Supply

This measure entails limiting the amount of parking available to motorists. The purpose of this strategy is to both encourage the use of non-auto modes and to reduce the actual and perceived difficulty of walking between nearby land uses. Restriction of parking needs to be implemented concurrent with alternative transportation options. It is generally recognized that most suburban areas oversupply parking, because they require each use to provide parking at close to its maximum need, and assume little use of

non-auto modes. Combined with the fact that each development in suburban areas is generally required to provide its own parking on-site, total parking supply in suburban areas can be nearly twice as great as the peak number of spaces actually utilized.[21] With the shorter walking distances and greater feasibility of transit and other modes that parking supply restrictions would help bring about, the need for parking would be further reduced.

Preferential Parking

This measure consists of reserving parking close to buildings for carpool and vanpool vehicles. Typically it is implemented at major employement sites where the cost, scarcity and distance of parking are factors that affect employees' commute choice. The visibility of the preferential parking for high-occupancy modes also serves as a marketing tool for such modes. Where a charge for parking exists, carpools and vanpools can be provided with a reduction or elimination of the parking charge. Requirements for the provision of carpool and vanpool spaces should be based on realistic expectations for their use to avoid overallocation and wasting space.

3.4 INDIVIDUAL STRATEGY EFFECTIVENESS

Table B-1 in Appendix B details the quantitative impacts of strategies as provided in the land use and transportation literature. This section provides an assessment of methodologies in the literature studies and an overview of study findings, and suggests which findings warrant the most or least confidence.

The research methods employed in many land use studies do not always fully support definitive conclusions. One reason is that it is difficult to develop, test, and control separate land use strategies to the degree required by rigorous experimental design methodologies. For example, it is hard to find perfectly comparable employers, parking, transit service and employees for a mixed-use site and a comparison site for purposes of studying the unique effects of mixed use development. Multivariate statistical analysis has been used in most studies. Without comparable controls, however, there is no certainty if the land use strategy or some other variables are bringing the observed travel results. Other important variables include traveler characteristics (gender, age, income, etc.) and destination characteristics (parking supply, price, congestion, safety, etc.).

There are other reasons to view land use studies in the literature with some caution. In many cases strategy effectiveness is projected by a model rather than assessed from experience. While models give us some confidence in projected results, they are not completely reliable. Furthermore, sometimes the

literature features results of a particular effective case study site. Whether the case study results would be replicated if carried out in other cases, sites or situations is not clear. Finally, there sometimes is a considerable range of results reported for a certain individual strategy. Reasons for the variation are not clear, but likely relate to the setting in which the strategy was implemented, the exact means of implementation or the presence/absence of important supporting variables such as quality of transit service or parking availability and price. For all these reasons, it is best to be cautious in interpreting the results of the literature, especially in projecting likely effects of individual strategies applied separately or on a site-specific basis. At best, the literature suggests potential ranges of effects and identifies variables important to determining outcomes.

One approach for developing the performance goals (described in Chapter 5) that was explored in this study was the use of a literature review of the effectiveness of various individual site-specific land use strategies. It was concluded that the simple application of travel reduction factors for individual site-specific strategies may be excessively optimistic if used to assess the potential cumulative effectiveness of land use strategies on a community-wide scale. Issues that arose in considering this approach were:

- reduction in impacts if more than one strategy is implemented, due to competing influences on travel behavior;
- published studies tend to focus on the most successful examples and the impacts may be difficult to achieve on average over an entire community; and
- the geographic area examined in the literature may be smaller than the entire area covered by a local jurisdiction, and the strategy would not have the reported impact over the entire jurisdiction.

After examining these issues, it did not seem to be a sound methodology to use the travel reduction factors for individual site-specific strategies from the literature in developing community-scale performance goals. However, the literature review was useful in providing a background regarding what individual strategies could achieve under certain conditions. It is especially important to note that a detailed understanding of what has been reported in other communities is essential to the development of credible strategy recommendations.

Transit-Oriented Design (TOD)

The literature indicates that providing convenient access to transit at residential and commercial developments will result in greater transit use to and from that development. For example, in the San

Francisco Bay Area, an analysis was conducted of two neighborhoods located near BART (heavy rail) stations to compare their travel modes for commute and shopping trips.[22] The neighborhoods had similar per capita incomes and about twenty percent of commuters used BART in both neighborhoods. However, the neighborhood with a transit-oriented design (TOD), that had higher densities and a mixture of uses within walking distance of the transit station, had a twenty percent lower drive-alone mode share for commute trips. In addition, less than fifteen percent of BART passengers drove to the BART station.

In regional evaluations, TODs have been found to result in lower VT and VMT. In the LUTRAQ (*Making the Land Use Transportation Air Quality Connection*) study, a model-based forecast was developed for the Portland Metropolitan Region to estimate the impacts of regional and subregional TODs.[23] Regionally, the analysis indicated that TODs could produce a reduction of VT by 7.7 percent and VMT by 13.6 percent, compared to a standard suburb in the region. Within the TODs, the model predicted twenty percent fewer home-based vehicle trips and ten percent greater transit usage in comparison to the standard suburb in the region. In Central New Jersey, a study of a hypothetical "transit construct" (mixed use centered on a major rail or bus stop) implemented throughout a region indicated that per person vehicle use would decrease by almost thirty percent in the peak periods and twenty-five percent in the off-peak periods compared to the standard suburb.[24] A study of neighborhood design and density using a transportation model in Melbourne, Australia, concluded that reductions of between thirty to fifty percent in neighborhood vehicle travel could be achieved from TOD design.[25]

Compared to modern developments, many areas developed before World War II were more oriented towards transit systems. Studies indicate that there is more transit use and less auto use in these developments. For example, an evaluation of neighborhoods in the San Francisco Bay Area indicates that households in pre-war neighborhoods average twenty percent fewer trips and twenty-five percent fewer auto-driver trips than households in neighborhoods that developed in the post-war era.[26] Although this study did not control for household size, auto ownership, or income (which is twenty-three percent less in the older neighborhoods), it does suggest the possible impact of orienting development patterns to the transit system. A matched-pair analysis of work trips in pre- and post-war neighborhoods in the San Francisco and Los Angeles regions controlled for income, density and transit service, to differentiate the unique effects of land use and street patterns. The study found that transit-oriented neighborhoods have a higher transit mode share in Los Angeles (1.3 percent) and in San Francisco (5.1 percent) than do conventional neighborhoods. Walking and bicycling shares were also higher in Los Angeles (3.3 percent) and San Francisco (6.6 percent).[27]

Overall, it appears TODs reduce solo driving mode shares or vehicle trips within the TOD area by twenty percent to fifty percent at the neighborhood level compared to conventional development patterns. Of course, stronger or weaker effects may actually occur, depending on implementation particulars and site characteristics, the location of the neighborhood within a metropolitan area, and the availability and level of transit service.

Density Near Transit Stations

One element of a TOD is an increased amount and density of development near existing and planned transit stations. (A transit station refers to a rail transit stop or a transit center that is served by numerous bus lines. A bus stop for single routes is not considered a transit station.) A number of studies have found that a factor that leads to greater transit use is the proximity of both the residence and employment site to rail stations.[28] Within walking distance of a rail station, transit use is significantly higher than for the surrounding region or for areas within driving distance of the rail station. Transit share declines as the distance from rail station increases over 1,000 feet.[29] Density is important to transit use. For example, in two urban areas of Canada, it was found that residents of high-density areas are thirty percent more likely to use transit than other residents located the same distance from the transit station.[30] A survey of housing preferences of high-tech workers in Silicon Valley found that sixty-five percent of the respondents said that they would use rail transit if it was located within one-half mile of both their home and employment site.[31]

The studies are quite uniform in their findings and conclusions. Cervero, JHK & Associates, and Stringham found higher transit use in both residential and employment centers closer to transit.[32] More transit use is also associated with higher density developments when distance from transit is controlled for. While the studies do not control for type of development, traveler characteristics or parking situations at the transit destination, the findings seem to apply across a great variety of developments, which lends some confidence to the results.

The literature suggests a range of increases in transit use can be expected from the strategy. Cervero finds up to about thirty percent of trips among residents near BART are non-auto. Further from BART, the proportion of non-auto trips ranges from a few percent to perhaps fifteen percent depending on the residential area.[33] JHK found residential use of transit declines by 0.65 percent by every 100 feet in distance from transit, and office use declined by 0.75 percent for every 100 feet of distance.[34] Stringham

finds that high density residents are thirty percent more likely to use transit at the same distance from rail stations as low density residents; however, the study did not control for characteristics of the residents.[35]

Density Near Transit Corridors

There is less quantitative data on how increasing densities near transit corridors affects travel behavior. (A transit corridor is an arterial or higher level roadway with a series of transit nodes that are no more than 1/2 mile apart and that are served by multiple bus routes and/or light rail lines.) Most prior research efforts have focused on corridor and areawide density associated with high use of rail transit or bus service.[36] An empirical study of the relationship between urban form and transit use found that transit usage triples for each doubling in density.[37] However, these studies did not control for other possible influences on transit use and therefore are more suggestive than conclusive.

Mixed-Use Development

Most studies of mixed-use developments do not control for employee characteristics, parking and other important determinants of travel behavior, so results can not be attributed solely to mixed use. Nevertheless, the studies are quite consistent in suggesting less vehicle trip making associated with mixed use. The Institute of Transportation Engineers finds eight percent trip reduction associated with mixed land uses.[38] Ewing finds that mixed-use communities generate between 2.3 and 2.8 vehicle hours of travel compared to 3.4 for auto oriented suburban communities.[39] JHK found a major mixed-use suburban activity center had seven percent transit use and twenty-five percent midday walk trips, which is significantly higher than typical suburban centers which had one percent transit and sixteen percent midday walk trips.[40]

A study by the Urban Land Institute does not directly address vehicle trip rates, but does indicate a high proportion of trips generated at mixed-use developments are amenable to non-auto use. In suburban settings, twenty-eight percent of trips from mixed-use developments were to nearby services and shopping, as compared to nineteen percent for non-mixed-use developments. In mixed-use developments in CBDs, sixty-one percent of trips were to nearby uses (compared to twenty-nine percent in non-mixed-use developments).[41] These findings suggest mixed use generates many more trips amenable to walking and cycling than non-mixed uses. Overall, it appears that a reduction on the order of eight percent might be possible at a site or within a neighborhood.

Infill and Densification

Prior research suggests that an increase in density can have an impact on travel behavior even if the increase in density is not within TODs or transit corridors. Several sources indicate that increasing residential density or increasing employment density will result in less auto travel per person and household.[42] In a study of San Francisco Bay Area communities, a doubling in residential density was associated with twenty to thirty percent less VMT per household.[43] A study of households in five neighborhoods in the San Francisco Bay Area found that higher densities were positively correlated with the percent of trips made by non-motorized modes of travel.[44] Similar results were found in an analysis of the 1990 National Personal Transportation Survey, but indicated that density increases at the lowest levels (e.g., from 1,300 to 2,700 persons/square mile) had no effect.[45] Much less use of single-occupant vehicles was found at employment densities greater than seventy-five employees/acre and at residential densities greater than fifteen persons/acre.[46] Overall, we may be reasonably confident that this strategy reduces vehicle trip making. Density can be a surrogate for urban characteristics such as mixture of uses, availability of transit services, and average income, to name a few.

Concentrated Activity Centers and Strong Downtowns

Because of the many similarities between these two strategies, much of the literature on activity centers applies to both concentrated activity centers and downtowns. They are therefore combined for discussion here. Studies have shown that developing activity centers and strong downtowns with a mixture of uses can result in significant reduction in vehicle use for internal trips. One study of six large-scale, multi-use suburban activity centers found that the larger the center, the greater the percentage of internal trips.[47] However, the compactness of the development and pedestrian design features impact the mode of travel for internal trips. The clustering of land uses was found to significantly reduce vehicle trip generation by up to sixty-five percent for non-residential uses and forty-five percent for residential uses.[48] In a study of employee travel, mixing of uses increased the use of nearby facilities by nine percent in suburban areas and over thirty percent in the downtown.[49] Overall, developing activity centers can increase the percentage of trips that are internal to the center, but, to significantly reduce vehicle travel, the center must be compact with clustered, mixed uses that are pedestrian accessible. Activity centers can also act as a node or transfer center for transit service.

Jobs/Housing Balance

There are limited and somewhat contradictory quantitative studies in the literature on this topic making it difficult to draw any definitive conclusions. For example, one study of fifty-seven areas concludes that a balance in jobs/housing is associated with three of five percent greater share of travel by walking, cycling and transit.[50] However, other research concludes that the strategy does not bring any significant travel-related benefits.[51] Jobs/Housing balance encompasses factors that are often beyond the direct control of cities and counties within their individual jurisdictions.

Pedestrian Facilities

The literature indicates that locating services and/or residences within walking distance of each other and providing adequate pedestrian facilities is associated with a greater walk mode share.[52] A study of pedestrian-oriented neighborhoods with similar per capita incomes located near BART stations in the San Francisco Bay Area found that twelve percent walked to supermarkets, fifteen percent fewer people drove to BART, and there were twenty percent fewer drive-alone trips.[53] The "walking construct" model developed by the Middlesex-Somerset-Mercer Regional Council projected eighteen percent fewer daily vehicle trips in PODs.[54] An empirical study of American walking behavior found that a pleasant/interesting environment can perhaps double the distance people are willing to walk.[55] A study of "pedestrian environment factors" in the Portland metropolitan region found that the pedestrian environment is a significant factor in explaining auto use.[56] Overall, the strategy might bring as much as twenty percent less use of autos within a particular development or neighborhood, though confidence in the finding must be tempered by the scarcity of controlled studies.

Interconnected Street Networks

Studies of this strategy are limited. The available research includes only modeling exercises or empirical studies without controls; however, the literature does suggest that providing an interconnected street network, such as a gridded street pattern, rather than cul-de-sacs and dead-end streets, can result in lower VMT due to access to more direct routes of travel. Friedman finds twenty-five percent fewer auto driver trips per household comparing pre-World War II and post-World War II neighborhoods, but fails to control for household or traveler variables.[57] Kulash predicts a forty-three percent reduction in VMT at the community scale, but the results are drawn from a model study that compares grids with cul-de-sacs.[58] Until more controlled studies are conducted for this strategy, it will be difficult to reach

conclusions with confidence about the magnitude of effectiveness. Current work indicates the range of effect might be up to a forty-three percent reduction in VMT in the immediately affected area.

Strategic Parking Facilities

A number of studies have found that parking supply impacts mode shares and the amount of vehicle travel.[59] One study found that when a parking lot was closed in an urban area in the Netherlands, there was a shift from single-occupant vehicles to transit and carpooling. In the short run, however, there was also an increase in emissions and VMT as a result of vehicles searching for parking.[60] Another study found that when alternate travel modes were available and relatively easy to access, vehicle use was reduced and therefore less parking is needed.[61] In a study of parking supply and parking pricing at hospitals in San Francisco, the amount of parking supplied was about one-third as important in predicting mode share as the cost for parking.[62] When parking supply was decreased and parking fees were increased at a school campus in Massachusetts, it was found that most of the impact on parking demand came from the reduction of parking spaces.[63]

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4. EXISTING LAND USE AND TRANSPORTATION CONDITIONS

To provide a basis for developing the performance goals described in Chapter 5, a number of sources of information were used. These included travel and land use data for California communities, case study evaluations of selected California communities, and travel and land use data for non-California communities.

4.1 DESCRIPTIONS OF COMMUNITY TYPES

The results of this research project are designed to be applicable to a wide variety of situations, rather than solely for a specific project or community. For this reason, three community types were identified and analyzed separately throughout the research project: urban, suburban, and exurban/rural. While there is significant variation in the characteristics of communities within each of these community types, the availability of data on strategy effectiveness did not allow for further stratification of the community types. This is an area that would benefit from additional research.

A summary description for each of the community types is provided in Tables 4-1 through 4-3. These descriptions are provided as general guidelines and do not have to be rigidly applied in determining a community type, which is somewhat subjective for each jurisdiction. This is especially true for a locality that may be in transition from one community type to another (e.g., from suburban to urban). In addition, some jurisdictions may contain both urban and suburban subareas. The timeframe being examined could impact the community type selected for such a transitional community, e.g., a 20-year timeframe vs. a 5-year period.

There are places that do not precisely match the characteristics described for each community type. In these cases, the function of the communities should guide the selection of the appropriate community type rather than size, centrality, density, or age of the community. Function refers to the type and complexity of uses found in the community and reflects whether the uses serve regional or local needs. Urban communities contain multiple, complex uses that serve regional needs, regardless of their size or density. In comparison, a suburban community may be a similar size and density to an urban community, but contain primarily residential uses and local-serving uses. Centrality refers to the location of a community relative to a central city and/or metropolitan area.

Table 4-1
DESCRIPTION OF AN URBAN COMMUNITY

FUNCTION:
- Full-range of uses, especially region-serving "high-order" functions in business and government; complex social, economic, and political life

SIZE:
- 50,000 population (Census threshold for MSA Central City); or
- 200,000 population contiguous metropolitan area (ISTEA)[1]

CENTRALITY:
- Primary and secondary central cities

DENSITY:
- Usually 10 dwelling units/net residential acre[2] or more

AGE/ERA DEVELOPED:
- World War II, in the central city

Table 4-2
DESCRIPTION OF A SUBURBAN COMMUNITY

FUNCTION:
- Limited range of uses compared to an urban community. Residential uses are predominant and most retail and public land uses serve local needs, although some region-serving retail and employment may be present

SIZE:
- Under 50,000 population (Census); or
- 50,000 - 200,000 population contiguous area (ISTEA)

CENTRALITY:
- Located within a Metropolitan Area centered on an urban area as defined above

DENSITY:
- Usually less than 10 dwelling units/net residential acre

AGE/ERA DEVELOPED:
- Post-WW II

[1]ISTEA: Intermodal Surface Transportation Efficiency Act

[2]Net residential acres do not include open spaces, streets, or commercial uses.

Table 4-3
DESCRIPTION OF A RURAL/EXURBAN COMMUNITY

FUNCTION:
- Limited range of uses, with agriculture, extractive industries, and open space predominant ("rural"); and/or
- Recreational, retirement, and residential uses are growing, even dominant aspect of local economy; increased rates of commuting to urban areas for employment ("exurban").

SIZE:
- Scattered settlements ≤ 2,500 population (Census); or
- Under 50,000 population contiguous area

CENTRALITY:
- Outside of a Metropolitan Area

One criterion for community classification is density. There are many ways to measure density when examining a community. Density for residential areas can be expressed for population or households, and can be measured according to gross acres (total land area) or net acres (not including open spaces, streets and non-residential uses). A comparison of density measurements, on average, for some California communities is provided in Table 4-4.

4.2 EXISTING CONDITIONS IN CALIFORNIA COMMUNITIES

Travel characteristics for twenty-six California communities that were examined in a study conducted by John Holtzclaw are used as representative examples for this research project. The communities described represent urban, suburban, and exurban communities and are located in the San Francisco, Los Angeles, San Diego, and Sacramento Areas. The data presented were taken from a study that examined odometer data (from the California Bureau of Automotive Repair) according to a number of detailed neighborhood descriptors[1].

Three of the four neighborhood descriptors provided in this report are summarized in Table 4-5: residential density, pedestrian accessibility, and transit service. Residential density is the number of households per net residential acre, excluding vacant units. (A net residential acre includes land for residential uses and excludes streets, open space, and commercial uses.) Pedestrian accessibility is a measure of neighborhood qualities that make a community inviting and safe to walk in. This index varies between zero and one and the qualities evaluated include the fraction of through streets, fraction of roadway with less than a five percent grade, fraction of the blocks with sidewalks, fraction of the streets that are traffic controlled, and average building setback from the sidewalk. The transit service index measures the number of transit vehicles and seats within walking distance of dwellings on a twenty-four hour basis. An index of neighborhood shopping, a measurement of the percent of residences with at least five critical local commercial establishments within one-quarter mile walking distance, was not summarized. The development of the qualitative ratings criteria is described in Appendix C.

Table 4-4
COMPARISON OF AVERAGE DENSITY MEASUREMENTS

	POPULATION DENSITY (POPULATION PER ACRE)	NET POPULATION DENSITY (POPULATION PER RESIDENTIAL ACRE)	NET HOUSEHOLD DENSITY (HOUSEHOLDS PER RESIDENTIAL ACRE)	RESIDENTIAL DENSITY (DWELLING UNITS PER RESIDENTIAL ACRE)
URBAN COMMUNITIES				
northeast San Francisco	49	200	101	110
central City of Sacramento	8	42	22	24
San Francisco (entire city)	24	114	48	52
central Berkeley	12	34	16	16
southwest Bevery Hills	19	27	14	14
Rockridge (Oakland)	8	21	10	10
east Sacramento/North Land Park	7	17	8	8
southern Santa Monica	15	28	15	16
southern Long Beach	16	70	24	26
Uptown San Diego	14	24	12	13
Urban Average				
Average Ratio to Population Density	17 1	58 3	27 2	29 2
SUBURBAN COMMUNITIES				
Alameda	10	29	12	13
south central Pasadena	14	22	10	11
Daly City	15	47	15	16
south Sacramento	9	19	7	7
central Downey	11	17	7	7
Alhambra	17	25	9	9
Escondido	2	11	4	4
Walnut Creek	5	11	5	5
Lafayette	2	6	2	2
Clairemont	9	16	6	7
northern Riverside	5	15	5	6
San Ramon	2	8	3	3
Los Altos/Los Altos Hills	2	5	2	2
Moreno Valley	4	12	4	4
La Costa	2	10	4	4
Suburban Average	7	17	6	7
Average Ratio to Population Density	1	2	1	1
EXURBAN COMMUNITIES				
Morgan Hill	2	7	2	2
Exurban Average	2	9	3	3
Average Ratio to Population Density	1	4	1	1

Source: John Holtzclaw, *Using Residential Patterns and Transit to Decrease Auto Dependency and Costs*, June 1994.
Grouped and annotated by consultant team and ARB staff.

Table 4-5
CHARACTERISTICS OF SAMPLE COMMUNITIES

COMMUNITY/LOCATION	RESIDENTIAL DENSITY	PEDESTRIAN ACCESSIBILITY	TRANSIT SERVICE
URBAN COMMUNITIES			
northeast San Francisco Nob, Russian and Telegraph Hills; Chinatown; North Beach and Fisherman's Wharf (central S.F. near downtown)	highest in the state	extremely high	extremely high
central Sacramento Near downtown	medium	moderate	high
San Francisco (entire city) Central city of the Bay Area region	high overall	high	extremely high
central Berkeley East of San Francisco (East Bay)	medium	very high	very high
southwest Beverly Hills 6 miles west of downtown Los Angeles	low to medium	extremely high	moderate
Rockridge Area of North Oakland/South Berkeley	low to medium	very low	very high
east Sacramento and north Land Park Adjacent to central city, to the south and east	low	moderate	low
southern Santa Monica 15 miles west of downtown Los Angeles	medium	very high	high
southern Long Beach 20 miles south of downtown Los Angeles	medium to high	extremely high	high
Uptown San Diego Pedestrian-oriented development near downtown San Diego	overall medium	moderate	moderate
SUBURBAN COMMUNITIES			
Alameda West of Oakland	medium	high	low
South Central Pasadena 9 miles northeast of downtown Los Angeles	low to medium	moderate	low
Daly City Borders San Francisco to the south	lower	very low	moderate
south Sacramento 5 to 10 miles south of downtown Sacramento	low	extremely low	extremely low
central Downey 10 miles southeast of downtown Los Angeles	low	low	very low

Table 4-5 (continued)
CHARACTERISTICS OF SAMPLE COMMUNITIES

COMMUNITY/LOCATION	RESIDENTIAL DENSITY	PEDESTRIAN ACCESSIBILITY	TRANSIT SERVICE
Alhambra 6 miles east of downtown Los Angeles	low to medium	high	low
Escondido 25 miles north of downtown San Diego	low	very low	very low
Walnut Creek 10 miles east of Oakland	low	very low	high
Lafayette Adjacent to and just west of Walnut Creek	overall low	extremely low	moderate
Clairemont 5 miles north of San Diego	low	very low	very low
northern Riverside 50 miles east of downtown Los Angeles	low	very low	extremely low
San Ramon 10 miles south of Walnut Creek	very low	very low	extremely low
Los Altos/Los Altos Hills 10 miles west of San Jose	very low	extremely low	very low
Moreno Valley Immediately east of Riverside (50 miles east of downtown LA)	very low	low	extremely low
La Costa 27 miles north of downtown San Diego (southeast corner of City of Carlsbad)	low	extremely low	extremely low
EXURBAN COMMUNITIES			
Morgan Hill 20 miles south of downtown San Jose	low	low	very low

Source: John Holtzclaw, *Using Residential Patterns and Transit to Decrease Auto Dependency and Costs*, June 1994, Appendix Tables 5 and 6.
Grouped and annotated by consultant team and ARB staff.

Notes: 1. The qualitative ratings criteria presented in this table are described in Appendix B-1.

4.3 CASE STUDIES OF CALIFORNIA COMMUNITIES

To more closely examine the relationship between travel behavior and land use characteristics, eight communities in California were examined as case study sites. The data presented for these case studies were obtained from phone interviews with city planners at each community, travel survey data available from the regional metropolitan planning organization (MPO), odometer data, and personal knowledge of the communities by members of the consultant team. The development and transportation/parking characteristics for each of the case study communities are described below. The use of the case study information in the development of the strategy recommendations is described in Chapter 6 of this report.

Northeast San Francisco

Development: Northeast San Francisco includes the communities of Nob, Russian and Telegraph Hills, North Beach, and Fisherman's Wharf. It is the highest density area in the San Francisco region and functions as a residential, cultural, and social center. Infill and densification have increased over the past twenty years as the city both revitalized and densified areas around transit stations when the rapid rail system (BART) was developed in the 1970s. Northeast San Francisco is within easy walking distance to the downtown business and commercial center.

Transportation/Parking: The street network is in a grid pattern, but some are steep or discontinuous at hillsides. Residents of this area average roughly 5,500 VMT per household (HH) per year. Pedestrian facilities include wide sidewalks, sidewalk level building entrances and crosswalks with pedestrian-actuated signals. Parking charges range from $3.00 to $10.00 per day, based on monthly parking rates. One-day parking charges are as high as $14.00 to $18.00. The area is well served by a regional rapid rail system (BART), the city transit system (which includes trolley buses and cable cars), and transit services (including ferries) from other counties in the region.

Greater San Francisco

Development: San Francisco is the primary city in the metropolitan region and has an overall density of 9.7 dwelling units (du) per gross acre. Commercial uses line many of the transit corridors and residential units fill areas between these corridors. Most residences are within a half-mile of schools and neighborhood businesses. Setbacks are small in residential areas and non-existent in commercial areas. Shopping districts are located in concentrated activity centers throughout the city. Because the city is built

out, new construction takes the form of redevelopment, intensification or infill. Office, commercial and residential uses are replacing older industrial uses. The city has significantly more jobs than housing.

Transportation/Parking: The entire city street pattern is a connected grid with pedestrian walkways connecting discontinuous streets. Travel surveys indicate there are about 1,270 VT and 5,950 VMT per HH per year, and 40 percent auto-driver mode share. A network of transit routes connects city residents and transfers commuters to employment centers throughout the city. There are a number of BART stations in the city. Parking in residential areas generally is controlled by preferential permit programs.

Oakland

Development: Oakland is a business and government center, with many regional, state, and federal offices. It is also a social and cultural center. Oakland's overall density is 4.3 du per gross acre and density is higher than this average near transit corridors and stations. Residential uses are adjacent to commercial areas and, in some cases, within the same blocks as commercial and industrial uses. The city has several activity centers outside of the downtown, but is also attempting to strengthen its downtown with the development of City Center, an office-retail complex around a rapid rail (BART) station. The city is developing middle-income housing next to City Center and is working to retain industrial uses employing residents of older neighborhoods. The city is built out, so most development is in the form of redevelopment, re-use or infill. There is an even balance of jobs and housing citywide.

Transportation/Parking: The city is connected by an integrated network of streets. The street pattern is a mixture of radiating arterials from downtown combined with a grid pattern. The downtown features wide sidewalks, pedestrian-actuated signals and building entrances off sidewalks. There are roughly 1,710 VT and 10,770 VMT per HH per year, and 55 percent auto driver mode share according to travel surveys. The downtown is well served by BART and a regional bus system (AC Transit). Parking prices downtown range between three and seven dollars per day on average.

Southern Long Beach

Development: Southern Long Beach provides business and social functions for the region. Much of the commercial activity is well distributed along major streets. The city is surrounded by the ocean and other developed areas, so new development is in the form of infill, densification, or redevelopment. The city's southern portion has a net residential density of 25.5 du per net residential acre (residential areas only, not including streets), and medium to high density housing is widespread throughout the community.

Transportation/Parking: The city street pattern is a regular and complete grid. It is one of the most pedestrian-oriented communities in the Los Angeles area, and most streets have sidewalks with few hillsides. According to odometer reading data, there are 15,252 VMT per household per year in Southern Long Beach. The community is served by local and regional bus routes,[2] and a light rail line connects Long Beach to downtown Los Angeles.

Daly City

Development: Daly City primarily serves as a residential suburb of San Francisco, although some business, employment, and region-serving retail are present. Overall density for the city is 17 du per gross acre and single family housing predominates. Lots are small (some as small as 2,500 to 3,000 square feet) and many units have been converted to accommodate two or three households. Some development is mixed use with retail on the ground floor and apartments above. In some blocks, a shopping center is located at one end with condominiums at the other. Two regional malls and several smaller malls are located in the city. The city is surrounded by the ocean, parks and developed areas, so new development is in the form of infill, densification or redevelopment. The city has more housing than jobs as it serves primarily as a residence for people working in San Francisco or at the San Francisco Airport.

Transportation/Parking: The city street pattern is in the form of a grid. The city has wide sidewalks and pedestrian activated signals. City plans include addition of landscaping, street furniture and signs to improve pedestrian amenities downtown. Travel surveys indicate that there are approximately 1,920 VT and 14,500 VMT per HH per year, as well as a 59 percent auto-driver mode share. Parking is priced through meters on the main commercial thoroughfare, but elsewhere is free. Supply is ample at shopping malls but tight on the main commercial thoroughfare.

Richmond

Development: The city is not a major employment center and more people live in the city than work there. The city is nearly built out, so most development is infill, densification or redevelopment. Overall density for the city is 8 du per gross acre, with denser development concentrated near transit stations and corridors. Commercial and residential districts border each other and most residents live within a mile of shops and transit routes. A mall and strip commercial areas within the city and Richmond has obtained designation as a federal enterprise zone.

Transportation/Parking: The downtown and older portions of Richmond have a grid street pattern. Winding streets and cul-de-sacs are found at waterfront and hillside developments. The downtown and other older portions of town have wide sidewalks and crosswalks. According to travel surveys, there are about 1,930 VT and 14,540 VMT traveled per HH per year, and 63 percent auto-driver mode share. Free or low cost parking is provided downtown and in the strip commercial areas. The regional shopping mall provides ample free parking.

Alhambra

Development: This residential community located six miles east of downtown Los Angeles is primarily low to medium density. Most of the shopping activity is concentrated in the older downtown, in a regional shopping center, and along two main arterials.

Transportation/Parking: The street system is not interconnected with the southern area of Alhambra cut off by the San Bernardino Freeway. Other areas have curvy and dead-end streets. Pedestrian access is made difficult in places by the absence of sidewalks, long blocks, and the lack of four-way stop signs or stoplights at many intersections. The community is served by thirteen bus routes.[3] According to odometer data, each household averages 21,660 VMT annually.

Mill Valley

Development: Mill Valley is a residential suburb. More people live in the city than work there, with most residents commuting to San Francisco or to nearby towns. The overall density is two du per gross acre, with downtown apartment density at 29 du per acre. Mixed use is not prevalent. The downtown is the primary shopping area but is not a major employment center. The city is surrounded by public open space and other development. Infill, densification and redevelopment are the only forms of development.

Transportation/Parking: Downtown streets form a grid pattern, while outside downtown, roads wind up canyon areas. Pedestrian facilities are good downtown and are connected to areawide hiking trails. Travel surveys indicate that there are about 1,700 VT and 14,150 VMT per HH per year, and 60 percent auto-driver mode share. Downtown parking is metered and the parking supply appears adequate, but not excessive compared to demand.

Fairfield

Development: Fairfield functions as a residential suburb. More people live in the city than work there. A local military base employs many people but access between it and residential areas is limited. Density is 1.3 dwelling units per gross acre and density does not vary much by proximity to transit. Residential and commercial uses are separated with most residences located more than a mile from shops. The downtown is not a major employment center. Commercial uses are located downtown and in suburban style centers. The city is not built out and much of the new development is in newly developed areas. However, the city has joined with neighboring cities and Solano County in adopting a greenbelt plan separating city developments.

Transportation/Parking: The city has a connected street grid system. The downtown has spacious, tree lined sidewalks and buildings oriented toward the street. According to travel surveys, there are roughly 2,500 VT and 19,980 VMT per HH per year, and 72 percent auto-driver mode share. Parking is inexpensive downtown and free elsewhere in the city.

Moreno Valley

Development: Moreno Valley functions as a residential suburb. More people live in the city than work there. Most residents commute to Irvine, Los Angeles or employment along regional freeways. Overall density is 1.1 du per gross acre and only half of the city's 52 square miles are developed. Mixed use is rare, and residents are more than a mile from commercial uses. Sunnymeade (the older downtown) is a two-mile, auto-oriented retail strip. Residents of Sunnymeade are within a half mile of stores, but pedestrian access is difficult. Plans are underway to allow residential uses on the commercial boulevard and to create mid-block connections between the boulevard and residential areas. The city contains a regional mall and community shopping centers. The city has room to grow and little incentive to build adjacent to existing development.

Transportation/Parking: Sunnymeade and the two older neighborhoods have grid streets. Sunnymeade has no sidewalks and long blocks make pedestrian access difficult between residential and commercial areas. According to odometer reading data collected by John Holtzclaw,[4] there are approximately 28,700 VMT per household per year in Moreno Valley. Newer neighborhoods have meandering streets, cul-de-sacs, and sidewalks. Parking is free and plentiful.

4.4 COMMUNITIES OUTSIDE OF CALIFORNIA

Travel and land use data were examined from communities outside of California to provide a basis of comparison for the characteristics found in California. Portland, Oregon, and some Canadian cities were selected as a focus because there are similarities to California communities in the age of the cities and in their development patterns. However, Portland and many Canadian cities have maintained higher transit use and have achieved higher densities of development. Therefore, they serve as potential models of improvement for California communities.

The travel and land use characteristics for Portland and several cities located in eastern Canada are described in this section. The reported travel characteristics for the Canadian cities are based primarily on the report *The Implications of Demographic and Socioeconomic Trends for Urban Transit in Canada: Case Studies Technical Appendix* prepared by Tranplan Associates for the Canadian Urban Transit Association, December 1991. Included are the two largest metropolitan areas in Canada: Toronto and Montreal. In general, Canada followed the U.S. trend away from public transportation and toward the private automobile during the middle portion of this century, but Canadian cities had the opportunity to observe the impacts of extensive freeway building and less dense development sprawl. The unpopularity of freeway projects, and increased awareness of environmental impacts, led to renewed interest in public transit and transportation/land use interaction.

The Canadian cities described in this section were selected based on the ready availability of data. In each case, the geographic boundary for a location was based upon the service area for the primary public transit provider. As such, all information provided is for the area within the transit service area, and not necessarily the entire metropolitan region. A summary of the key travel and land use characteristics for these locations is presented in Table 4-6. A description of each city is presented below.

Portland

The Portland metropolitan region is the largest urban area in the State of Oregon. In 1988, the population of the Portland metropolitan region was approximately 1.3 million with an average of 2.5

Table 4-6

LAND-USE AND TRAVEL CHARACTERISTICS FOR SELECTED CANADIAN CITIES

CITY	COMMUNITY TYPE	POPULATION (1986)		DAILY PER PERSON VEHICLE TRIP RATE
		TOTAL	DENSITY (PER SQ. MILE)	
Montreal Island	Urban	1,734,156	9,000	1.0
Quebec City	Urban	460,000	2,900	1.4
Toronto	Urban	2,192,721	9,000	1.5
Ottawa-Carlton	Urban/Suburban	567,409	4,100	1.8
Suburbs of Montreal				
South Shore	Suburban	336,000	3,700	1.4
Laval	Suburban	284,000	3,300	1.5
Mississauga	Suburban	359,948	3,300	1.5
London	Suburban	276,000	4,000	1.8
St. Catherines	Suburban	140,000	3,400	1.9

Source: Tranplan Associates, *The Implications of Demographic and Socioeconomic Trends for Urban Transit in Canada: Case Studies Technical Appendix*, prepared for the Canadian Urban Transit Association, December 1991.

persons per household.[5] The region has areas with high residential density and areas with low residential density. Portland has a strong downtown that is an employment and retail center and is well served by transit. There is a transit mall in downtown Portland that is serviced by buses and light rail, and transit use is free within the downtown.

In a study of pedestrian accessibility issues,[6] the pedestrian friendliness of an area was measured using "pedestrian environment factors" that range from 4 to 12. The pedestrian environment factor was uniquely defined for this study and values were assigned to each traffic analysis zone in the region, with 12 representing the most pedestrian-friendly areas. (These values do not correspond to the values developed by John Holtzclaw). A comparison of the travel characteristics between those areas with a pedestrian environment factor of 12 and the total region is provided below.

	VEHICLE TRIPS PER HOUSEHOLD PER YEAR	VMT PER HOUSEHOLD PER YEAR
Pedestrian Environment Factor = 12	1,500	6,200
Portland Region	2,000	10,600

The areas with a pedestrian environment factor of 12 include downtown Portland and the downtowns of some of the older cities in the region. These areas tend to have the highest densities, the most mixture of uses, and the best transit service. In the downtown, about forty percent of the person trips are by auto drivers during peak commute hours.

Montreal

The Montreal region is the second largest urban area in Canada and is located in the Province of Quebec. Montreal Island is located within the banks of the St. Lawrence River and encompasses approximately 500 square kilometers (sq. km.). The City of Montreal is the focal point of the Island, although twenty-seven additional municipalities are located on the island. Montreal has a large and vital downtown core that is the main employment focus in the Greater Montreal Area. In 1986, the population of Montreal Island was estimated to be over 1.7 million with an average population density of 3,475 persons/sq. km (9,000 persons/square mile). Densities on the Island, however, vary significantly: from less than 400 persons/sq. km. (1,040 persons/square mile) in the western portion of the island, to as high

as 35,880 persons/sq. km. (93,000 persons/square mile) in the central districts of Montreal city. Interestingly, the average household size is much higher in the western districts than the central districts.[7]

Montreal Island is served by an extensive bus system and heavy rail service (a subway with limited commuter rail service). Public transportation carries approximately 34 percent of the daily person trips in the region. Based on the reported rates for the number of trips by a motorized mode and assumed average vehicle occupancy, the average daily per person vehicle trip rate was calculated as 1.0. The high transit use and low vehicle trip rate are reflective of the low auto ownership rate, compared to the United States, of under 370 vehicles per 1,000 people and a parking availability rate of less than 80 spaces per 1,000 jobs in the central area. The auto ownership rate in the United States in 1990 was 690 vehicles per 1,000 people.[8]

Quebec City

Quebec City is also located in the Province of Quebec along the St. Lawrence River. The reported data for Quebec City include the city and its environs that are served by the Quebec Urban Community Transit Commission. The population of the Quebec City area was approximately 460,000, with an average density of over 1,120 persons/sq. km. (2,900 persons/square mile). The average daily per person vehicle trip rate for Quebec City was 1.35 VT per person. Transit accounts for 18 percent of the daily person trips.[9]

Toronto

Toronto is the largest urban center in Canada, serving as its most important commerce and trade center. The population of the Toronto urban area served by the primary public transit provider is approximately 2 million. The population of the entire Toronto metropolitan area is closer to 3 million. Toronto is often viewed as a model of how transit and land use can be effectively integrated. Urban density and transit use are high by North American standards. Between 1960 and 1980, Toronto increased population density and transit use, quite contrary to the trends experienced in U.S. and Australian cities. The average density of the Toronto urban area is 3,500 persons/sq. km. (9,000 persons/square mile), and census tracts within the central core of Toronto have densities as high 54,500 persons/sq. km. (141,000 persons/square mile). Densities of population and employment are approximately three times higher in Toronto's suburbs than in the suburban areas of the U.S.'s ten largest metropolitan areas.[10]

Metropolitan Toronto is served by an integrated transit system of buses, trolley coaches, streetcars and subway routes. The Greater Toronto area is also served by commuter and light rail service. This transit system serves approximately 28 percent of the daily trips in the Toronto area. The downtown core of Toronto has approximately 7 percent of the metropolitan area's population, and 31% of the jobs. Parking availability in the downtown core is only 210 spaces per 1,000 jobs. Over 80 percent of all trips into the downtown core area are by transit. At retail centers located near suburban rail stations, about 24 percent of all customers arrive by modes other than automobile. Vehicle use is comparatively low, despite auto ownership levels as high as in Australia and many U.S. cities (493 vehicles per 1,000 people). The estimated daily vehicle trip rate is 1.50 VT per person.

A 1986 travel survey conducted in the Greater Toronto Area also provides information on distances traveled by automobile.[11] By converting kilometers to miles, it was estimated that average daily vehicle travel by residents of central Toronto is 5 VMT, and by residents of outer suburban Toronto is 11 VMT per person. In comparison to American suburbs, Toronto suburbs experience half as much VMT per person.[12]

Ottawa

Ottawa is the national capitol of Canada with a strong downtown core focused on federal government activities. The combined region of Ottawa/Carleton had a population of 567,409 in 1986. The central area has a compact urban form, while the newer suburban municipalities are characterized by auto-oriented subdivisions and shopping malls. Densities in the central core are as high as 11,500 persons/sq. km. (30,000 persons/square mile), while those in the outlying areas fall below 500 persons/sq. km. (1,300 persons/square mile). The average density for the region is 1,589 persons/sq. km. (4,100 persons/square mile). There is extensive bus service to the region, including express service on exclusive busways. Twenty-one percent of the daily trips are by transit. The average daily trip rate for the region is 1.9 VT per person.[13]

South Shore

South Shore includes the suburban communities south of Montreal that are served by the STRSM transit service. The South Shore area includes some key activity centers, such as Longueuil, but Montreal is the urban focal point for the entire region. In 1986, the area's population was 336,000. The areas closest to Montreal have high densities, but these get progressively lower as development spreads southward. Population densities varied from 120 to 19,500 persons/sq. km. (310 to 50,000

persons/square mile), with an average of just over 1,400 persons/sq. km (3,600 persons/square mile). Transit service is primarily provided via a bus system, although heavy rail service into Montreal is available. The average daily vehicle trip rate is 1.4 VT per person.[14]

Laval

Laval is a suburban community located just north of Montreal. In 1986, the area's population was 284,000. The average population density for the area was 1,268 persons/sq. km. (3,300 persons/square mile), varying from 30 to 9,300 persons/sq. km. (80 to 24,000 persons/square mile). Transit service is primarily provided via a bus system although heavy rail service is provided into Montreal. The average daily vehicle trip rate is 1.5 VT per person.[15]

Mississauga

Mississauga is a suburban area located just west of Toronto. In 1986, the area's population was approximately 360,000. Population densities varied from 50 to 11,200 persons/sq. km. (130 to 29,000 persons/square mile), with an average of just over 1,260 persons/sq. km. (3,300 persons/square mile). Transit service is primarily provided via a bus system although heavy rail service is provided into Toronto. The average daily vehicle trip rate is 1.5 VT per person, the same as that for neighboring Toronto.[16]

London

London is located approximately 200 kilometers southwest of Toronto. The London Transit service area had a population of 276,000 in 1986, with an average density of 1,560 persons/sq. km. (4,000 persons/square mile). Densities varied from 300 to 6,050 persons/sq. km. (780 to 15,700 persons/square mile). Transit service is provided via a bus system and accounts for 10 percent of daily trips. The average daily vehicle trip rate is 1.4 VT per person.[17]

St. Catherines

The City of St. Catherines is located about 10 miles from Niagara Falls on the south shore of Lake Ontario, across from Toronto. The population of St. Catherines was 140,000 in 1986. Population densities varied from 45 to 3,470 persons/sq. km. (120 to 9,000 persons/square mile), with an average of just under 1,300 persons/sq. km. (3,400 persons/square mile). The bus-based transit service accounted for 5 percent of the area's daily trips. The average daily vehicle trip rate was 1.5 VT per person.[18]

4.5 CHAPTER ENDNOTES

1. John Holtzclaw, *Using Residential Patterns and Transit to Decrease Auto Dependence and Cost,* prepared for the Natural Resources Defense Council, June 1994.

2. Ibid.

3. Ibid.

4. Ibid.

5. Cambridge Systematics, Inc. and Calthorpe Associates, *Existing Conditions,* Volume 2, Making the Land Use Transportation Air Quality Connection, prepared for 1000 Friends of Oregon, October 1991.

6. Parsons Brinkerhoff Quade and Douglas, Inc. with Cambridge Systematics, Inc. and Calthorp Associates, *The Pedestrian Environment,* Volume 4A, Making the Land Use Transportation Air Quality Connection, prepared for 1000 Friends of Oregon, December 1993.

7. Tranplan Associates, *The Implications of Demographic and Socioeconomic Trends for Urban Transit in Canada: Case Studies Technical Appendix*, prepared for the Canadian Urban Transit Association, December 1991.

8. Patricia S. Hu and Jennifer Young, *Summary of Travel Trends, 1990 Nationwide Personal Transportation Survey,* Center for Transportation Analysis, Oak Ridge National Laboratory, prepared for the Federal Highway Administration, March 1992, p. 6.

9. Tranplan Associates.

10. Ibid.

11. *The Transportation Tomorrow Survey: Travel Survey Summary for the Greater Toronto Area,* prepared by the Data Management Group of the University of Toronto/York University Joint Program in Transportation, June 1989.

12. Tranplan Associates.

13. Ibid.

14. Ibid.

15. Ibid.

16. Ibid.

17. Ibid.

18. Ibid.

5. PERFORMANCE GOALS FOR CALIFORNIA COMMUNITIES

Within each of the three community types, individual jurisdictions will vary in the amount of air quality improvement that they are trying to achieve from transportation-related land use strategies. The amount of air quality improvement will be based on a combination of the severity of nonattainment of the air quality standards and the contribution to air quality improvement that is expected from other strategies such as demand management measures, pricing strategies, and stationary source controls. The findings from this research project are reported in a way that allows local jurisdictions to use the information developed in a customized fashion for their particular needs. Local jurisdictions may choose to define their community types, select performance goals, and select strategies to implement.

Three levels of travel activity have been developed in this research project that can serve as performance goals for local jurisdictions. The three levels of performance goals are specified for each community type that reflect differing implementation of transportation-related land use strategies. The performance goals are expressed in average annual vehicle trips (VT), vehicle miles traveled (VMT), mode shares, and pollutant emissions per household. This chapter provides a summary of the methodology used to develop the three levels of performance goals for each of the three community types and guidance on how to monitor the effectiveness of the transportation-related land use strategies after they are implemented.

To use the performance goals developed in this research project, a local jurisdiction would first need to define itself as being an urban, suburban or exurban community using the descriptions provided in Chapter 4. This definition could either apply to current conditions or to the type of conditions the community expects to evolve in the future. For example, a currently exurban community may be in the process of becoming suburban and so may wish to select strategies appropriate for a suburban community. After selecting a community definition, the jurisdiction would then develop an estimate of its current baseline travel characteristics to determine a starting point in comparison to the performance goals. Sources of that data include MPO or COG travel demand models, Caltrans, and other resources mentioned in Section 5.1. Depending upon the amount of air quality improvement desired from the transportation-related land use strategies, the jurisdiction would choose which performance goal level may provide the necessary amount of air quality benefit. Not all jurisdictions will necessarily need to achieve the highest level of performance goals stated. In fact, the highest level of the performance goals have

been intentionally set to be a marked improvement over the existing conditions currently found in many areas of California.

5.1 METHODOLOGY FOR SETTING PERFORMANCE GOALS

The performance goals have been set as targets that many communities can reasonably achieve with a concerted effort to implement the recommended transportation-related land use strategies. The values selected for the highest level of performance goals represent an improvement over travel patterns that result from current land use development and transportation systems in California.

The development of the performance goals was based on the information collected, analyzed and reviewed for this research project. The review of the literature on the impacts of land use on travel behavior was used to examine the potential effectiveness of individual strategies and as a general resource throughout the research effort. Estimates of individual strategy effectiveness were one input examined in the development of the performance goals. Travel survey data and household odometer reading data from communities in California were used to provide a description of how existing travel conditions vary with differing land use patterns.[1] Because this research is part of an effort to achieve an improvement over existing conditions, data were also collected from communities located outside of California that provide examples of effective land use and transportation planning. In the remainder of this section, the process of developing the performance goals is described.

Baseline Data

The first step in developing the performance goals was to establish baseline travel data for California communities related to existing land use and transportation conditions. In selecting appropriate baseline travel data for community types, several potential data sources were examined, which are described below. One potential resource was the Highway Performance Monitoring System (HPMS) developed by the U.S. Department of Transportation. This system is intended to bring together data at a national level to assess the status of the Nation's highways. Volume counts are collected for all freeways and a sample of other major highways, but arterials and lower classes of roadway facilities are not generally included in the HPMS. It was determined that the HPMS was not an adequate data source for this project because the volume count data could not be directly translated to VT, VMT, or mode share. In addition, it is not possible to separate personal and commercial travel, and a significant portion of the vehicle travel in an area is not included in the HPMS.

Travel survey data collected between 1981 and 1991 were also examined to identify existing travel conditions for communities in California. The travel data examined included daily VT per person, daily VMT per person, and travel mode share. While an initial effort was made to use the travel survey data in setting the performance goals, the consultants and ARB staff determined that it was not adequate for the purposes of this study. Travel survey data tend to be biased towards those respondents most likely to fill out the survey, and do not always capture all travel in a household. Also, travel by commercial vehicles is also often underrepresented. In addition, most local jurisdictions do not have easy access to travel survey data.

Another option considered was BURDEN, which is one of several computer programs used by the ARB in the estimation of on-road vehicle emissions for counties and air basins in the state. Included in BURDEN are travel data derived from information provided by the MPOs, DMV, Caltrans, and other transportation agencies. Sources of information include regional travel demand models, the Caltrans Statewide Travel Survey, and Caltrans State Highway Traffic Volumes. Unfortunately, it was not possible to use the BURDEN activity data in the development of the performance goals because these data are reported only by county, many of which contain a combination of community types, and not by specific communities. Using the BURDEN activity data, therefore, would not have allowed an accurate segmentation by type of community within a metropolitan area. A summary of BURDEN vehicle activity data for VT and VMT per person per year by county is provided in Appendix F. In addition, mode-of-travel data by region (from the *1991 Statewide Travel Survey*)[2] are provided in Appendix G. This information is provided as baseline data for local jurisdictions, although local jurisdictions are encouraged to use their own data if available. (note: a methodology to convert daily travel values to annual values comparable to the Performance Goals is provided in Appendix E.)

Holtzclaw Study

Dr. John Holtzclaw recently conducted a detailed examination of vehicle odometer data from twenty-eight sample California communities, along with other land use and transportation characteristics. The odometer data was provided by the California Bureau of Automotive Repair (as a result of the State's smog check program).[3] The purpose of this study was to examine sample neighborhoods and determine whether certain land use and transportation characteristics are associated with lower rates of automobile use. The study's evaluation of average annual VMT for households in selected communities throughout California is relevant to this research project.

Holtzclaw examined both annual average VMT per person and VMT per household (per HH). For this research project, the consultants and ARB staff selected VMT per HH because the relationship between density and annual VMT is more closely statistically correlated with households than with population.[4] In general, annual odometer readings are more directly related to the household's annual travel than to an individual person. Odometer data includes longer recreational trips that contribute VMT outside of the region in which the household is situated, which tends to inflate the data somewhat as a measurement of daily travel. However, it was decided that odometer data would be used for this project because it avoids some of the deficiencies associated with other sources of travel data, and (importantly) because it is accompanied by quantified information on land use and transportation characteristics for the same sample communities in California in which the odometer data was collected.

Holtzclaw found a significant correlation between travel behavior and certain land use and transportation characteristics. A thorough statistical analysis of the study results revealed a significant relationship between community density and the annual average household VMT. However, Holtzclaw's findings were not conclusive about the importance of income and demographics in relation to travel mode behavior. A recent study of travel in five neighborhoods in the San Francisco Bay Area conducted for the ARB concluded that demographic and socio-economic attributes were <u>not</u> the primary explanatory variables of differences in travel behavior. It found that "differences in neighborhood characteristics--in particular residential density, public transit accessibility, mixed land use ... and the presence of sidewalks--are significantly associated with trip generation by mode and modal split."[5]

Consultants and ARB staff (Terry Parker) examined Holtzclaw's data on average VMT per HH per year as well as the other land use and transportation characteristics of the sample communities to determine reasonable segmentations into performance goal levels. The first step in this process was the identification of community types for each of the case study communities in Holtzclaw's study. The definitions described in Chapter 4 of this report were used to differentiate between the urban, suburban and exurban communities that Holtzclaw studied.

Table 5-1 provides a summary of the travel, land use density, transit availability, mixture of land uses and pedestrian accessibility of twenty sample California communities, grouped by community type. As described in Chapter 4, household density is the number of housing units per net residential acre (excluding streets, open spaces, commercial uses, etc.) The "transit accessibility index" measures the

Table 5-1
COMMUNITY CHARACTERISTICS

SAMPLE COMMUNITY*	VMT PER HOUSEHOLD PER YEAR[1]	HOUSEHOLD DENSITY [2]	TRANSIT SERVICE [3]	MIXED USE [4]	PEDESTRIAN ACCESS [5]
URBAN COMMUNITIES					
northeast San Francisco	5,500	101	90	1.0	.7
central Sacramento	10,100	22	20	.2	.4
San Francisco (entire city)	11,300	48	70	.8	.5
central Berkeley	12,500	16	49	.2	.6
southwest Beverly Hills	13,000	14	13	.7	.7
Rockridge	14,300	10	27	.2	.1
southern Santa Monica	14,700	15	20	.7	.6
southern Long Beach	15,300	24	19	.6	.7
Uptown San Diego	15,500	12	9	.5	.4
SUBURBAN COMMUNITIES					
Alameda	17,000	12	7	.2	.5
south central Pasadena	17,300	10	6	.4	.4
Daly City	19,300	15	13	.2	.1
central Downey	21,400	7	2	.2	.2
Alhambra	21,700	9	5	.2	.4
Escondido	21,700	4	2	<.1	.1
Walnut Creek	22,300	5	21	.1	.1
Lafayette	22,300	2	11	.1	<.1
Clairemont	22,700	6	2	.1	.1
northern Riverside	23,700	5	1	.1	.1
EXURBAN COMMUNITY					
Morgan Hill	28,400	2	3	.1	.2

* *(Source and descriptions on next page)*

Table 5-1 (continued)
COMMUNITY CHARACTERISTICS

Source: Dr. John Holtzclaw, *Using Residential Patterns and Transit to Decrease Auto Dependence and Costs*, June 1994. Grouped and annotated by consultant team and ARB staff. (please see Appendix D)

Notes:
1. Average annual vehicle miles of travel per household within each community from vehicle odometer data, provided by the California Bureau of Automotive Repair.
2. Number of households per net residential acre (excluding streets, open space, commercial uses, institutions, etc.).
3. Measure of the number of transit vehicles per hour available within 1/4-mile walking distance of dwellings on a 24-hour basis.
4. Portion of households within 1/4-mile walking distance of five or more key local commercial services (e.g., market, restaurant, drugstore). (note: Original data has been rounded to the nearest 10th.)
5. Measure of neighborhood qualities that make a community inviting and safe for pedestrian travel, including: level terrain (<5% grade), sidewalks, convenient building entries, frequent intersections, and traffic signals. (note: Original data has been rounded to the nearest 10th.)

number of transit vehicles per 24-hour period that are accessible to a community's residential population. This index varies from a low of 1 to a high of 90. "Mixed Use" quantifies the portion of households within a 1/4-mile walking distance of neighborhood commercial services, and varies from a low of <0.1 to 1. Finally, the "pedestrian accessibility index" also varies from <0.1 to 1, with '1' representing better access for walking and bicycling. It measures factors such as an interconnected street pattern, sidewalks, convenient building entrances, safe traffic speeds and gentle street slopes. (Please refer to Appendix D for a more detailed description and more complete listing of these measurements.)

Selecting a Community Type

For some communities, selection of the appropriate community type is straightforward (e.g., San Francisco is an urban area). For other communities, there can be disagreement about community type depending upon the definitions of a community, especially when individual community quantitative characteristics do not fit precisely into the guidelines described in Chapter 4 (Tables 4-1, 4-2, and 4-3). For this project, a number of factors were used to define each of the community types: function, population, centrality, density, and age. The function of a community and its location relative to other urban and suburban communities are the primary factors used in determining its type. For example, Alameda is a city in the San Francisco Bay Area that has a population density (12 households (HH) per net residential acre) that is greater than the suggested definition of 10 HH per net residential acre for suburban areas. However, it functions as a suburb to other central urban communities (Oakland and San Francisco), and so it is classified as suburban rather than urban. Allowing some flexibility in the density and population characteristics when defining community type will provide the opportunity to recommend appropriate strategies.

Setting the Performance Goals

JHK and ARB staff first classified the sample communities according to community type, with special emphasis on the function of the community within the region. Next, available information on the case study communities, including the data listed in Table 5-1, was used to rank the communities according to their land use and transportation characteristics. Sample communities in each community type were then listed in ascending order of average annual VMT per household. Next, ranges for the performance goal levels were identified based on what appeared to be reasonable break points in the data. The results of this analysis are summarized in Table 5-2, which provides a listing of the communities divded into levels within each of the three community types. The performance goal ranges are provided in the right-hand column of Table 5-2. The ranges reflect variations at each level for each of the three types of communities. Only two levels were set for exurban areas because of the limited baseline data available.

Table 5-2
DEVELOPMENT OF PERFORMANCE GOALS

SAMPLE COMMUNITY	REGIONAL LOCATION	VMT PER HOUSEHOLD PER YEAR	PERFORMANCE GOALS: AVERAGE VMT PER HOUSEHOLD PER YEAR
URBAN COMMUNITIES			
northeast San Francisco	San Francisco (SF) Bay Area	5,500	**Urban Level 1 <10,000**
central Sacramento	Sacramento	10,100	**Urban Level 2 10,000 to 13,000**
San Francisco (total)	SF Bay Area	11,300	
central Berkeley	SF Bay Area	12,500	
southwest Beverly Hills	Los Angeles	13,000	
Rockridge	SF Bay Area	14,300	**Urban Level 3 13,001 to 16,000**
southern Santa Monica	Los Angeles	14,700	
southern Long Beach	Los Angeles	15,300	
Uptown San Diego	San Diego	15,500	
SUBURBAN COMMUNITIES			
Alameda	SF Bay Area	17,000	**Suburban Level 1 <20,000**
south central Pasadena	Los Angeles	17,300	
Daly City	SF Bay Area	19,300	
central Downey	Los Angeles	21,400	**Suburban Level 2 20,000 to 22,000**
Alhambra	Los Angeles	21,700	
Escondido	San Diego	21,700	
Walnut Creek	SF Bay Area	22,300	**Suburban Level 3 22,001 to 25,000**
Lafayette	SF Bay Area	22,300	
Clairemont	San Diego	22,700	
northern Riverside	Los Angeles	23,700	
EXURBAN COMMUNITIES			
(No case study communities available)			**Exurban Level 1 <28,000**
Morgan Hill	SF Bay Area	28,400	**Exurban Level 2 28,000 to 30,000**

Source: John Holtzclaw, *Using Residential Patterns and Transit to Decrease Auto Dependence and Costs*, June 1994. Grouped and annotated by consultant team and ARB staff.

Although there is no lower bound specified for Level 1 (so as not to restrict what a jurisdiction could accomplish), a jurisdiction at some point may transform from exurban to suburban or from suburban to urban. Not all of the sample communities examined from Holtzcalw's study are included in Table 5-2. Because Level 3 is set to be an improvement for some communities, there are some sample communities that are below Level 3 (e.g., San Ramon and Los Altos with a VMT per HH per year of 28,200 and 26,100 respectively). Therefore, those communities with average per-household VMT higher than Level 3 are not included in the performance goal levels.

The data available from the Holtzclaw study was useful in setting performance goals for VMT. However, vehicle trip (VT) and travel mode share information cannot be obtained from odometer readings. To supplement the odometer data, travel survey data for those communities for which odometer reading data were also available were used. The travel survey data included VT per person, VMT per person and mode share between auto drivers and others (i.e., auto passengers, transit users, bicyclists, pedestrians). A summary of the travel survey data is provided in Table 5-3. Daily travel survey data on a per-person basis and annual odometer reading data on a household basis are not directly comparable, even when the travel survey data are converted to annual or per-household values.

To use the travel survey data as a basis for specifying the VT performance goals, a ratio of VT to VMT was estimated for each of the California communities. This ratio was developed using two approaches. In the first approach, the ratio of the VT to VMT values was calculated for each community and an average was taken of these ratios. The average ratio was 0.16. In the second approach, the VT over all of the communities was first summed and then the VMT over all of the communities was summed. The ratio of the summed VT to the summed VMT was estimated (a weighted average) and the resulting value was 0.16. Because both approaches resulted in the same average value, 0.16 was selected to be the ratio of VT to VMT. Assuming that the ratio of VT to VMT is similar for travel survey data and odometer data, this ratio was then applied to the VMT performance goals to develop the VT performance goals. Mode share data were used directly from the travel surveys. Where there were not sufficient data for each area type and performance goal level, mode shares for communities outside of the sample were used.

Table 5-3
TRAVEL CHARACTERISTICS OF SELECTED COMMUNITIES BASED ON TRAVEL SURVEY DATA

COMMUNITY	VT PER PERSON PER YEAR	VT PER HOUSEHOLD PER YEAR *(estimated)**	VMT PER PERSON PER YEAR	AUTO DRIVER MODE SHARE[5]
Downtown San Francisco[1,2,3]	210	481	1,560	NA[6]
San Francisco[1,2,3]	555	1,610	2,600	40%
Berkeley[1,2,3]	695	1,800	3,300	45%
Oakland[1,2,3]	660	1,709	4,160	55%
Daly City[1,2,3]	730	1,898	5,500	59%
Walnut Creek[1,2,3]	900	2,376	6,940	66%
Toronto[4]	520	NA	NA	NA
Central City	NA		1,740	NA
Outer Suburb	NA		3,800	NA

Sources:

1. California Department of Transportation, *1991 Statewide Travel Survey: Summary of Findings*, November 1992.

2. Deakin, Harvey, Skarbadonis, Inc., Tabulations of the *1981 Bay Area Travel Survey*, March 1991.

3. Hu, Patricia S. and Jennifer Young, *Summary of Travel Trends, 1990 Nationwide Personal Transportation Survey*, Center for Transportation Analysis, Oak Ridge National Laboratory, prepared for the Federal Highway Administration, March 1992.

4. *The Transportation Tomorrow Survey: Travel Survey Summary for the Greater Toronto Area*, prepared by the Data Management Group of the University of Toronto/York University Joint Program in Transportation, June 1989.

Notes: 5. Percent of Person Trips
6. NA - Not Available

* Annual VT per person data converted to "estimated" per household data using *1990 U.S. Census higher California Population and Housing Estimates*, April 1990; "average persons per household by county."

The final step in verifying the reasonableness of the performance goals was to compare the Level 1 values to the travel data from communities outside of California that have efficient land use and transportation patterns. The data available for Canadian cities are primarily daily VT per person obtained from travel surveys. Although these data are not directly comparable to the performance goals, some general comparisons were made. Based on the travel survey data, the VT per person per year for Montreal Island and Quebec City is below the VT per person per year for San Francisco and Berkeley.

Also, the VMT per person per year for central Toronto is comparable to the VMT per person per year for downtown San Francisco. The suburban Canadian communities examined in Chapter 4 all have a VT per person per year that is approximately ten to thirty-five percent lower than the VT per person per year for Daly City. This provides some verification that the Urban Level 1 and Suburban Level 1 performance goals are achievable with certain transportation-related land use strategies in place. Suburban residents of Canadian cities average roughly half as much VMT per household as do suburban residents of the sample California communities.

Emissions goals were estimated by ARB staff for the travel-based performance goals using emissions factors from EMFAC7F1.1 and BURDEN7F developed for statewide fleet averages for light and medium duty vehicles and motorcycles for 1995. (The calculation procedure used is provided in Appendix H; the emissions values listed are the vehicle emissions on a per household per year basis, but do not account for emissions from increased use of public transit or carpool vehicles, or access trips.)

5.2 PERFORMANCE GOALS

Using the methodology described above, together with significant input from ARB staff (Terry Parker), performance goals were developed for three levels for each of the three community types. A summary of the performance goals is provided in Table 5-4. Within each community type, the average per-household annual rate of motor vehicle use decreases from Level 3 to Level 2 to Level 1. This translates into a decrease in VT per HH per year, VMT per HH per year, and auto-driver mode share of person trips. Mode shares for transit, walking, and car/vanpooling increases from Level 3 to Level 1. The amount of change in each travel characteristic is not necessarily the same between levels.

These goals are intended to be general guidelines. A community may meet or exceed one or more of the performance goals listed, but fall somewhat short in another category. Each area of the state

Table 5-4
PERFORMANCE GOALS

	VEHICLE TRIPS[1]	VMT[2]	MODE SHARE OF PERSON TRIPS[3]		EMISSIONS[6]
			AUTO DRIVER[4]	OTHER[5]	
URBAN COMMUNITIES					
Level 1	<1,600	<10,000	40%	60%	ROG: <31 CO : <348 NO: <27
Level 2	1,600 to 2,100	10,000 to 13,000	45%	55%	ROG: 31-40 CO: 348-455 NOx: 27-35
Level 3	2,101 to 2,600	13,001 to 16,000	55%	45%	ROG: 40-50 CO: 455-562 NOx: 35-43
SUBURBAN COMMUNITIES					
Level 1	<3,200	<20,000	60%	40%	ROG: <62 CO: <696 NOx: <54
Level 2	3,200 to 3,500	20,000 to 22,000	65%	35%	ROG: 62-68 CO: 696-763 NOx: 54-59
Level 3	3,501 to 4,000	22,001 to 25,000	70%	30%	ROG: 68-77 CO: 763-870 NOx: 59-67
EXURBAN COMMUNITIES					
Level 1	<4,500	<28,000	65%	35%	ROG: <87 CO: <977 NOx: <76
Level 2	4,500 to 4,800	28,000 to 30,000	70%	30%	ROG: 87-93 CO: 977-1044 NOx: 76-81

Notes:
1. Per household per year, on average
2. Vehicle miles traveled per household per year, on average
3. The percent of trips made by individuals by a given mode of travel
4. Auto Drivers include single occupant vehicles and drivers of carpools and vanpools (40% means that for 100 person trips there are 40 vehicles on the road).
5. "Other" includes all non-motorized forms of transportation, transit riders, and passengers of car/vanpools
6. Average pounds per household per year total emissions from light and medium duty vehicles and motorcycles (see Appendix H for methodology). (ROG - Reactive Organic Gases; CO - Carbon Monoxide; NOx - Oxides of Nitrogen)

has different combinations of travel characteristics that may not result in the precise relationship between vehicle trips, VMT, and mode share expressed in the performance goals.

Some jurisdictions in the state would improve their air quality by achieving any of the levels of performance goals listed for their community type. For those jurisdictions that want to maximize their air quality improvement from transportation-related land use strategies, Level 1 has been set so that it represents an improvement for almost all areas of the state (Northeast San Francisco being the exception). However, all jurisdictions will not achieve Level 1 for their community type. Instead, these performance goals, and the subsequent strategy recommendations described in Chapter 6, are meant to encourage local jurisdictions to strive for that level that is challenging yet achievable.

In examining Table 5-4, within each community type, there is an improvement in the amount of vehicle emissions moving from Level 3 to Level 2, and from Level 2 to Level 1. For example, if a suburban jurisdiction were to move from the midpoint of the range for Level 3 to the midpoint of the range for Level 2, it is estimated that the reduction in vehicle emissions would be about ten percent for each of the pollutant emissions. Going from the midpoint of Level 2 to the upper boundary for Level 1 would result in an estimated pollutant emission reduction of about five percent. Using Urban Levels 2 and 3 as another example, VT per HH per year for Level 2 is approximately twenty-five percent lower than Level 3 and VMT per HH per year is approximately thirty percent lower. In this case, fewer vehicle trips are taken in Level 2 and the trips that are taken are shorter than those in Level 3. Also, there is no reason to assume continuity within one level and across area types. For example, if a suburban area develops into an urban area, the level that it would have achieved would not necessarily be expected to stay the same (e.g., Level 1 Suburban to Level 1 Urban).

The ARB has adopted vehicle emissions standards for new motor vehicles that will result in cleaner air. Because of these standards, the air quality benefits from reduced use of motor vehicles will decline over time. Therefore, the emissions rates provided in Table 5-4 should not be used to forecast future emissions reductions associated with the performance goals. Future years' vehicle emission factors are provided in Appendix H.

Achievement of the performance goals will be difficult for local jurisdictions to monitor. Emissions benefits are especially difficult to monitor. Some guidelines for monitoring changes in travel patterns are described in Appendix I.

5.3 CHAPTER ENDNOTES

1. John Holtzclaw, *Using Residential Patterns and Transit to Decrease Auto Dependence and Cost*, prepared for the Natural Resources Defense Council, June 1994.

2. California Department of Transportation, *1991 Statewide Travel Survey: Summary of Findings*, November 1992.

3. Holtzclaw.

4. John Holtzclaw, *Explaining Urban Density and Transit Impacts on Auto Use*, presented by the Natural Resources Defense Council and the Sierra Club to the State of California Energy Resources Conservation and Development Commissions, April 19, 1990.

5. Ryuichi Kitamura, Patricia Mokhtarian and Laura Laidet, *A Micro-Analysis of Land Use and Travel in Five Neighborhoods in the San Francisco Bay Area*, prepared for the California Air Resources Board, November 1994.

6. TRANSPORTATION-RELATED LAND USE STRATEGY RECOMMENDATIONS

In this chapter, packages of strategies that will assist local jurisdictions in attaining a specific set of performance goals are described. The recommended strategy packages were developed based on the information obtained in the data collection phase of this project and are designed to help communities achieve the performance goals. One package of recommended strategies is presented for each of the eight sets of performance goals (three levels each for urban and suburban, and two levels for exurban communities).

For a local jurisdiction to determine which strategy package to pursue, the jurisdiction should first identify its community type, based on the definitions provided in Chapter 4 of this report. Then, the local jurisdiction should determine the performance goal (described in Chapter 5 of this report) that best meets its needs. The local jurisdiction can then reference the package of strategies from this chapter that corresponds to the chosen community type and performance goal level. From the package of strategies, the strategies that have already been implemented in the jurisdiction can be identified, and a listing of additional strategies can be generated that will help achieve the desired performance goals.

While it is expected that implementing these strategies will help reduce or avoid vehicle travel, it is important to note that the transportation-related land use strategies evaluated in this research project do not directly impact travel behavior. Rather, implementing these strategies provides travelers with opportunities to use alternate modes of travel rather than driving alone. Other factors also may impact/reduce the effectiveness of transportation-related land use strategies which could be addressed through other policies if even greater reductions in vehicle travel are desired. Examples include:

- the lack of high quality transit service, which would impact the number of travelers that have ready access to transit;
- relatively low cost for auto travel in general, including gasoline prices, licensing fees, and tolls, which help to make driving an inexpensive mode of travel; and
- safety and crime concerns that may impede the use of the transit system and pedestrian areas.

Another issue to be taken into account when examining the effectiveness of transportation-related land use strategies is the timeframe in which the strategy is to be implemented. In general, the strategies recommended here are long-term strategies because development takes time; however, long-term could mean five years or it could mean twenty years. Each situation will be unique depending upon the amount of air quality improvement that is targeted for these strategies, the amount and type of existing development, and the expected growth rate for future development. A local jurisdiction should consider the time required for implementation when projecting air quality benefits from transportation-related land use strategies.

The packages of transportation-related land use strategies recommended in this report are not the only combinations of strategies that will successfully achieve these goals. Each jurisdiction in California possesses unique characteristics that would require customizing the strategy recommendations for every situation, which is not within the scope of this research project. Instead, what is presented here are strategies that can reasonably be implemented and that are expected to eventually achieve the desired results. Each package of strategy recommendations is based on a reasonable (but conservative) estimate of the effectiveness of individual strategies and combinations of strategies. There may also be situations where the performance goals can be achieved by implementing fewer strategies, a less stringent implementation of the individual strategies, or both. The packages have been developed so that a local jurisdiction can reasonably be expected to achieve the performance goals if other non-land-use factors do not inhibit alternate mode use. This approach will help to ensure that the recommendations will be useful to a wide range of jurisdictions.

6.1 DEVELOPMENT OF STRATEGY RECOMMENDATIONS

The development of the strategy recommendations was based upon all of the data collected for this project. Initially, results of the literature review were examined to determine whether the information could be used in a quantifiable methodology in the development of the strategies. There were two significant limitations to this approach. The first was that many strategies were implemented at a site or in a specific area. The results presented for these strategies may be accurate for the study area, but it may not be accurate to conclude that these impacts are consistent across an entire jurisdiction. For example, increasing the density of development near transit stations usually results in travel impacts near the transit station, which would not occur throughout the jurisdiction. The second issue was that the most successful case studies were more likely to be reported in the literature. While this provides important

information regarding the characteristics of a successful example, it may not be realistic to use these case studies to represent average conditions.

The information obtained from the literature review was useful in the development of initial strategy packages for each of the eight sets of performance goals. Because of the limitations stated above, each individual strategy's effectiveness was carefully considered to ensure it was not overstated. With the data currently available, it is not possible to precisely quantify how the strategies impact each other when implemented together, but there are strategy recommendations that appear to be effective when implemented together. For example, it makes sense that there will be more pedestrian activity in a dense development near a transit station if the development includes a mixture of uses and has pedestrian facilities in place.

Two of the strategies evaluated for this project are not included in the final list of strategy recommendations: *Transit-Oriented Design* and *Jobs/Housing Balance*. They were not recommended in part because the beneficial aspects of each is incorporated into the strategy recommendations (listed below). For example, the individual characteristics in the strategy *Transit-Oriented Design* are reflected in the recommendations: *Increase Density Near Transit Stations*, *Increase Density Near Transit Corridors*, *Encourage Mixed-Use Development*, and *Provide Pedestrian Facilities*. The productive aspects of the jobs/housing balance strategy are embodied in the concept of *Encourage Infill and Densification*, which promotes increasing employment and housing opportunities on underutilized or vacant parcels. In addition, proximity to residential areas is a supportive factor for the strategy *Develop Concentrated Activity Centers*.

To provide some verification that the strategy packages were reasonable, the case studies of California communities previously described were reviewed to determine what types of transportation-related land use strategies are currently in place, and how their implementation corresponds to travel behavior. Both the presence of specific strategies and any quantifiable aspects of the strategies were identified. The packages of strategy recommendations were then revised to incorporate the review of selected communities. The final recommendations for the strategy packages are presented in the following section.

6.2 RECOMMENDED STRATEGY PACKAGES

The recommended strategy packages are presented as eight tables (Tables 6-1 through 6-8 provided at the end of this chapter), each of which corresponds to a set of performance goals by community type and level of effort. The performance goals for each community type and level are listed at the top of each table. This section provides a description of how the recommended strategy package tables are organized, as well as a description of how each land use and transportation strategy may vary with different jurisdictional characteristics.

Each strategy in the tables includes a description, a list of strategy characteristics, and contributing factors. The description is a brief summary of the strategy as it is being recommended. The strategy descriptions provided in the Chapter 3 should be used if more detailed information is needed. The characteristics column provides any quantitative descriptions of the strategy recommended for that community type and level of performance goal. The characteristics also include primary concerns or requirements related to the strategy; some of the strategies include residential density as a characteristic. Figure 6-1 (also provided at the end of this chapter) illustrates what these densities might look like, and a more detailed description of the development of the densities and the mixture of uses is provided in Appendix J. The proposed densities are recommended minimums rather than targets that should not be exceeded. The strategy characteristics are general in nature and are not meant to be restrictive.

The final column in the table is a listing of supportive factors that are necessary for the strategy to achieve its full effectiveness. As an example, a strategy that is predicted to increase walking, such as a mixed-use development, would not be as effective if adequate pedestrian facilities are not provided. Similarly, transportation-related land use strategies will clearly not be effective in encouraging the use of transit service if there is little or no transit service provided.

One of the supportive factors that is included in the tables is the discouragement of auto-oriented land uses in certain locations. It is important to recognize that not all land uses can be served by alternate travel modes, and that there are some land uses that are inherently oriented to automobile use. Examples include automotive repair shops and large-package retail stores. Large parking lots, walls, fences, and other barriers interfere with pedestrian travel and access to transit. These types of land uses may be present and necessary in a community, but should not be located near a transit- or pedestrian-oriented area in place of another land use that may benefit from the availability of alternative modes of travel.

The transportation-related land use strategy recommendations are grouped by how they are implemented: at a neighborhood/district level, or at a community level. Two groupings of strategies are also listed that are not recommended as necessary, but which may be pursued if certain conditions are present. There is no priority or importance assigned to specific strategies in each package because it is recommended that all of the strategies listed in each table be implemented to achieve the indicated performance goals. Additionally, these recommendations do not include minimum requirements for the size of a jurisdiction to effectively implement the transportation-related land use strategies, although the size could impact effectiveness.

The strategy packages also include strategies that should be pursued, or at least considered in overall planning efforts, to prepare for the progression to a higher level of a performance goal in the future. However, it is not expected that every jurisdiction will strive to achieve the Level 1 Performance Goals for its community type. This will depend upon individual needs to improve air quality and any other emissions-reducing strategies that are implemented. Some jurisdictions will be able to anticipate a need to progress to a higher level in the future than is currently required. As an example of these strategies, *Strengthen Downtowns* is not included as a necessary strategy in the recommendations for the performance goals for Urban Level 3. It is included, however, for both Levels 1 and 2 for Urban areas. Therefore, if a local jurisdiction foresees the desire to achieve the Level 1 or 2 performance goals in the future, it will best be prepared by considering the need for a stronger downtown. In particular, it is important to ensure that intermediate policies are not enacted that will inhibit the development of a strong downtown.

The final grouping in the strategy packages indicates which strategies, while not required, should be pursued if the basic infrastructure exists for strategy implementation. The strategy recommendations developed were based on the expected conditions for each of the community types. For example, many suburban areas do not have transit stations (a bus stop is not necessarily considered a transit station), but this is not a requirement to achieve the Level 2 or Level 3 performance goals. The strategy recommendations are not meant to discourage local jurisdictions from implementing what may be a very effective strategy just because it is not necessary for all similar areas. As an example, suburban areas that do have one or more transit stations located within their jurisdiction should pursue increased density in the developments surrounding the transit station. This will also increase that jurisdiction's ability to meet the performance goals and to progress to a higher level in the future.

Not all of the strategies examined in this research project are included in the recommended strategy package for each area type and performance goal level. However, this is not meant to discourage the implementation of any of the recommended strategies. Rather, the strategy packages have been developed to incorporate those efforts that seem reasonable for a jurisdiction in a particular community type and that would be expected to help achieve the stated performance goals. Including too many strategies could result in an overly ambitious listing of strategies that might discourage implementation.

All of the evaluated strategies are recommended for Urban Level 1, Urban Level 2, and Suburban Level 1. For some of the strategies, the degree of implementation is reduced as the performance goals become less strenuous. For Urban Level 3, only the strategy *Strengthen Downtowns* is not recommended, because urban areas can achieve the stated performance goals without having a strong downtown core. *Strengthen Downtowns*, however, is listed as a strategy to be pursued if a progression to Urban Level 1 or 2 would be desired in the future.

Not all suburban areas have transit stations located within their jurisdictions. Therefore, the strategy packages for Suburban Levels 2 and 3 have been developed without a reliance on the strategy *Increase Density Near Transit Stations*, although it is recommended that this strategy be pursued if a local jurisdiction does have one or more transit stations. For Suburban Level 2, all of the remaining strategies have been recommended. The strategies *Develop Concentrated Activity Centers* and *Strengthen Downtowns* are not included for Suburban Level 3, but they are recommended if the local jurisdiction has determined that it may wish to reach a Level 1 or 2 in the future. *Develop Strategic Parking Facilities* is also not recommended for Suburban Level 3 because the performance goals can be met without having to reduce the parking supply. Most exurban areas also do not possess a transit station, so *Increase Density Near Transit Stations* is recommended only if a transit station does exist. Similarly, many exurban areas have developed without a downtown core, and *Strengthen Downtowns* is recommended as a strategy to be pursued only if a downtown currently exists.

For Exurban Level 1, each of the remaining strategies is included as a recommendation, but to a lesser degree than in the urban and suburban areas. For both Exurban Level 2, *Develop Strategic Parking Facilities* and *Develop Concentrated Activity Centers* are not included as recommended strategies because they would be extremely difficult to implement in most exurban areas. For those exurban areas

that do have transit corridors, *Increase Density Near Transit Corridors* should be pursued if progression to Exurban Level 1 is desired in the future.

The strategy packages presented in this chapter are one approach to achieving the performance goals. As described above, jurisdictions may have circumstances precluding them from implementing all of the recommended strategies. Where this is the case, additional strategies should be substituted, or another strategy should be implemented more intensely than indicated (e.g., a higher number of dwelling units per acre), or over a larger portion of the community. The strategy recommendations can also be used by a local jurisdiction that faces constraints in implementing transportation-related land use strategies to determine what the maximum level of a performance goal can be expected to be achieved. As mentioned previously, it is not expected that all jurisdictions will, or should, strive to achieve the Level 1 Performance Goals developed in this research project.

6.3 RECOMMENDED STRATEGIES

The final list of recommended strategies is:

- Provide Pedestrian Facilities
- Increase Density Near Transit Corridors
- Increase Density Near Transit Stations
- Encourage Mixed-Use Development
- Encourage Infill and Densification
- Develop Concentrated Activity Centers
- Strengthen Downtowns
- Develop Interconnected Street Network
- Provide Strategic Parking Facilities

Not all strategies are recommended for each community type or performance goal level. Details of strategy package recommendations are provided in Tables 6-1 through 6-8. Examples of locations where the recommended strategies have been implemented are listed in Table 6-9 at the end of this chapter.

6.4 FACTORS AFFECTING STRATEGY IMPLEMENTATION

The strategies in the recommended packages differ based on the area type and the level of performance goals that a local jurisdiction is trying to achieve. Recommended characteristics are generally guidelines and not to be taken as standards. When making land use decisions, local officials must take into account many other factors, including existing characteristics of a neighborhood, surrounding land uses, available infrastructure, and impacts on public services. There are also other factors that may impact how a strategy is implemented in a particular situation. A discussion of these factors is provided below for each of the strategies. (A general description of the strategies can be found in Chapter 3). Table 6-9

factors is provided below for each of the strategies. (A general description of the strategies can be found in Chapter 3). Table 6-9 identifies some locations where each of the strategies has been implemented and the specific land use types for which each strategy applies.

Provide Pedestrian Facilities

This strategy should be implemented in all areas where there are land uses that are amenable to pedestrian use. In isolated areas with a limited need for pedestrian access, good pedestrian amenities (e.g., wide sidewalks and pedestrian priority at signalized intersections) will not provide a significant change in travel behavior. Pedestrian facilities and good access for pedestrians is a very important component of nearly all of the other strategies.

Increase Density Near Transit Corridors

The location of specific types of land uses will vary based on the level of transit service and the distance between transit stops. The most transit- and pedestrian-oriented uses should be located closest to the transit stops. If there are locations along the corridor where transit stops are farther than 1/2 mile apart, the focus of compact and intense development (e.g., a multi-story building that combines residential and commercial uses) should be as close as possible to the transit stops. The implementation of this strategy may require coordination with the transit service provider to optimize the location of certain land uses and the transit stops.

Increase Density Near Transit Stations

Each transit station should be examined to determine whether it serves, or could serve, the origin end and/or the destination end of most of the trips to the station. If the transit station is located in a primarily residential area where most of the trips served are origins, then residential development and commercial services that support that residential development should be the primary focus of any new, dense development. If the transit station is located where most of the trips are destinations, such as a major employment center, then the focus of new development should be greater densities for the destination types already present. Mixed-use development near a transit station that encourages the use of the station for both the origin end and the destination end of trips can help to avoid one-way peak commutes that waste transit capacity. Also, complementary land uses should be included in the new development. For example, if the transit station primarily serves an employment center, commercial land uses that employees would use should be included, such as a dry cleaners, a cafe, or a newsstand.

Transit stations that are designed to serve a mixture of origins and destinations should be surrounded by a variety of commercial, employment and residential land uses that are transit-oriented.

Encourage Mixed-Use Development

The minimum percentages for the mixture of land uses varies for urban and suburban areas. This reflects the expectation that suburban areas have a greater percent of residential land uses than do urban areas, which are likely to have a higher concentration of commercial and employment land uses. Providing a mixture of uses is especially important in suburban communities with nearly all residential development, where their residents must otherwise travel long distances to other communities for shopping and recreation as well as employment. Jurisdictions should attempt to attract businesses to the community that match the locally-available labor. The recommended strategy for urban and suburban areas includes a mixture of housing, commercial uses, and public uses. Commercial uses should provide services that are required by the nearby housing. For example, if the housing includes families with smaller children, then a daycare center would be an appropriate commercial use, as would retail oriented to children. There are no minimum percentages of land use types required for exurban areas.

Encourage Infill and Densification

In an urban metropolitan area, the primary emphasis for infill and densification is in the city center and in already-existing pockets of dense development, preferably with existing or anticipated transit service. The compactness (density of residential uses and intensity of commercial uses) of the development may be greater in urban or metropolitan areas than in suburban or exurban areas that are not in a major metropolitan area. In a suburban or exurban area, it may not be immediately obvious where pockets of more compact development should be located. In these cases, locations should be chosen that have the best potential for improved transit service and that are centrally located. It is important to use an infill strategy to reduce remote suburban development (that requires long trips to employment in city centers) that may otherwise occur and to cluster density so that it can be served more efficiently by transit. Most communities allow a certain number of future multi-family units (e.g., apartments, condominiums); however, these need to be strategically located and clustered so that they can be served efficiently by transit and generally reduce reliance on vehicles. Examples of types of residential structures that can be built at a variety of densities are illustrated in Figure 6-1, "Character of Residential Density."

Develop Concentrated Activity Centers

The development of a concentrated activity center could be considered one form of infill and densification, but with an emphasis on the development of a center that can attract regional travel. Also, a concentrated activity center may not necessarily be an infill development. This strategy would be implemented differently for stand-alone communities than for communities that are surrounded by other communities in a major metropolitan area. In a stand-alone community, the local jurisdiction has more direct control over the number and extent of development of concentrated activity centers. In a major metropolitan area, the development of concentrated activity centers should be examined in a regional context. The purpose of developing concentrated activity centers is to focus primary employment centers in relatively few locations so that it is easier to provide transit service and for employees to car/vanpool in comparison to development that scatters individual buildings. If each local jurisdiction develops one or more concentrated activity centers, or locates the centers in a way that competes with other centers, then the intent of this strategy is defeated.

Strengthen Downtowns

A downtown is a specialized form of a concentrated activity center and efforts to strengthen the downtown by making it a primary employment and cultural center are likely to depend on infill and densification efforts. This strategy may apply to an already-existing downtown or to a primary commercial and employment center that can become a downtown. Similar to concentrated activity centers, not every jurisdiction would require a strong downtown if they are located in a major metropolitan area where, from a regional perspective, it makes more sense to develop fewer strong downtowns. This is not to say that there cannot be multiple downtowns that act as primary places of employment and cultural centers, but the number that a metropolitan area can reasonably support must be examined.

Develop Interconnected Street Network

An interconnected street network, often a gridded pattern, is one in which the streets are interconnected and there are few, if any, areas with dead end streets or clusters of streets that can only be accessed from one direction. This strategy is much easier to incorporate in new developments. It may be difficult, if not impossible, to change the structure of already existing streets. Where this is the case, the emphasis should be placed on providing pedestrian and bicycle paths that directly link the streets.

It is also much more likely that an already-existing integrated street network will be present in urban areas and in areas that were developed before World War II, which were predominantly built around a gridded street network.

Provide Strategic Parking Facilities

The emphasis of this strategy should be on not oversupplying free parking that acts as a disincentive to using transit and as a physical barrier to pedestrians. Any changes to existing parking policy must be made considering all components of the parking facilities at the same time. For example, it would not make sense to limit parking supply at specific developments and than allow an excess of parking within easy walking distance. In that case, all that would be achieved is to shift where people park, not the mode that they use to travel. Neighborhoods surrounding commercial or employment areas are particularly sensitive to the potential for parking to overflow onto their neighborhood streets. Specific recommendations are not made for the amount of parking that should be supplied. This will vary significantly depending on the types of land uses present (e.g., many types of retail have high parking demands) and the availability and quality of transit service.

Table 6-1
URBAN AREA - LEVEL 1 SCENARIO

	Jurisdiction's Baseline Travel Characteristics[1]	PERFORMANCE GOALS LEVEL 1 (Very Low Auto Travel)
VT/Household/Year	_____	<1,600
VMT/Household/Year	_____	<10,000
Auto Driver Mode Share of Person Trips	_____%	40%

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Neighborhood or District-Level		
Provide Pedestrian Facilities Pedestrian routes to encourage walking	Design features include: - crosswalks and pedestrian-actuated traffic signals - traffic light or stop sign at least every 500 ft on arterials - wide sidewalks (5-10 ft) - protection from fast vehicular traffic - short block-faces - minimal building setbacks - on-street entries to buildings	- Neighborhood services within ½ mile of most residences - Direct connections for pedestrians and bicycles - Integrated street pattern - Routes that link compact, clustered development - Traffic calming measures
Increase Density Near Transit Corridors Compact residential and commercial uses within ¼ to ½ mile of major transit corridors	Residential density at minimum of 50 du/net residential acre, on average. Commercial intensity at minimum of 330 employees/net commercial acre, except theaters and hotels (FAR about 1.6)	- Pedestrian facilities - **15-min. transit headways or less** - Multiple bus routes - Integrated street pattern - New auto-oriented uses discouraged along corridor
Increase Density Near Transit Stations Compact residential and commercial uses within ¼ to ½ mile of stations	At least 70 du/net residential acre, on average. Commercial intensities at minimum of 360 employees/net commercial acre, except theaters and hotels (FAR about 2.2)	- Pedestrian facilities - **15-min transit headways or less** - New auto-oriented uses discouraged near stations

Notes: 1. Refer to baseline data described in Chapter 4 and Appendix E. These data should be specific to the jurisdiction if available.

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-1 (continued)
URBAN AREA - LEVEL 1 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
• **Encourage Mixed-Use Development** Mixed use residential and commercial development. Vertical and horizontal mixed-use, i.e., within and between buildings	Goals for larger sites; minimum % of gross floor area: Office center: - Office 45% - Retail 10% - Public 5% Retail-cultural center: - Retail, hotel, entertainment 30% - Office 10% - Public 10% - Residential 5% Residential area: - Residential 30% - Retail 10% - Public 10% - Office 5% Neighborhood center: - Residential 20% - Retail 15% - Public 15% - Office 10%	- Pedestrian and bicycle facilities - Integrated street pattern - Services within walking and bicycling distance of workplaces (¼ mile)
Community Level		
Encourage Infill and Densification Infill development to create clusters of higher residential density and to add employment to jobs-poor urbanized areas	Residential density at a minimum of 32 or more du/net residential acre, on average.	- Pedestrian and bicycle facilities - Integrated street pattern - Employment centers and retail services near residential clusters - Transit service to residential clusters

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-1 (continued)
URBAN AREA - LEVEL 1 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Develop Concentrated Activity Centers (CACs) Primary employment concentrated in a limited number of carefully planned centers with functionally-integrated complementary uses, including residential	The number of CACs will vary with the size of the jurisdiction and metropolitan area.	- Auto uses discouraged for internal circulation - Pedestrian facilities - Provision of services for employees - Transit service - Proximity to residential areas
Strengthen Downtowns Single or predominant city center incorporating a primary employment center, with supporting housing, commercial, and region-serving public and cultural uses		- Direct pedestrian routes to surrounding neighborhoods - Pedestrian facilities within the downtown - Excellent local and regional transit connections - Commercial buildings oriented to the sidewalk
Develop Interconnected Street Network Regular grid or other interconnected street system	Encourage multiple, narrow streets over isolated, hierarchical multi-lane arterials	- Pedestrian/bicycle connections - Short blocks
Provide Strategic Parking Facilities Provide less parking supply to reflect the increased transit use and walking/bicycling occurring as a result of implemented strategies. Management of parking should vary by land use type and proximity to transit service. Parking should facilitate, not inhibit, walking and transit	- Workplace parking managed at all locations - Supply does not exceed demand - On-street parking controlled - Parking shared among uses - Priority parking for bicycles, HOVs and ZEVs	- Pedestrian and bicycle facilities - Mixed uses within walking distance - Transit service (amount varies by situation)

(J:\3100\URBAN1.TK6)

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-2
URBAN AREA - LEVEL 2 SCENARIO

	Jurisdiction's Baseline Travel Characteristics[1]	PERFORMANCE GOALS LEVEL 2 (Low Auto Travel)
VT/Household/Year	_____	1,600 to 2,100
VMT/Household/Year	_____	10,000 to 13,000
Auto Driver Mode Share of Person Trips	_____%	45%

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Neighborhood or District-Level		
Provide Pedestrian Facilities Pedestrian routes to encourage walking	Design features include: - crosswalks and pedestrian-actuated traffic signals - wide sidewalks (5-10 ft) - protection from fast vehicular traffic - short block-faces - minimal building setbacks - on-street entries to buildings	- Neighborhood services within ½ mile of most residences - Direct connections for pedestrians and bicycles - Integrated street pattern - Routes that link compact, clustered development - Traffic calming measures
Increase Density Near Transit Corridors Compact residential and commercial uses within ¼ to ½ mile of major transit corridors	Residential density at minimum of of 32 du/net residential acre, on average. Commercial intensity minimum of 310 employees, /net commercial acre, except theaters and hotels (FAR about 1.9)	- Pedestrian facilities - **15-min. transit headways or less** - Multiple bus routes - Integrated street pattern - New auto-oriented uses discouraged along corridor

Notes: 1. Refer to baseline data described in Chapter 4 and Appendix E. These data should be specific to the jurisdiction if available.

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-2 (continued)
URBAN AREA - LEVEL 2 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Increase Density Near Transit Stations Compact residential and commercial uses within ¼ to ½ mile of stations	At least 50 du/net residential acre, on average. Commercial intensities at minimum of 340 employees/net commercial acre, except theaters and hotels. (FAR about 2.1)	- Pedestrian facilities - 15-min transit headways or less - New auto-oriented uses discouraged near stations
Encourage Mixed-Use Development Mixed use residential and commercial development. Vertical and horizontal mixed-use, i.e., within and between buildings	Goals for larger sites; minimum % of gross floor area: Office center: - Office 40% - Retail 10% - Public 5% - Residential 5% Retail-cultural center: - Retail, hotel, entertainment 25% - Office 10% - Public 10% - Residential 10% Residential area: - Residential 35% - Retail 10% - Public 10% - Office 5% Neighborhood center: - Residential 20% - Retail 15% - Public 15% - Office 10%	- Pedestrian and bicycle facilities - Integrated street pattern - Services within walking and bicycling distance of workplaces (¼ mile)
Community Level		
Encourage Infill and Densification Infill development to create clusters of higher residential density and to add employment to jobs-poor urbanized areas	Residential density at a minimum of 22 du/net residential acre, on average.	- Pedestrian and bicycle facilities - Integrated street pattern - Employment centers and retail services near residential clusters - Transit service to residential clusters

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-2 (continued)
URBAN AREA - LEVEL 2 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Develop Concentrated Activity Centers (CACs) Primary employment concentrated in a few carefully planned centers with functionally-integrated complementary uses, including residential	The number of CACs will vary with the size of the jurisdiction and metropolitan area.	- Auto uses discouraged for internal circulation - Pedestrian facilities - Provision of services for employees - Transit service - Proximity to residential areas
Strengthen Downtowns A dominant city center or primary employment locale, with supporting housing, commercial, and region-serving public and cultural uses		- Direct pedestrian routes to Surrounding neighborhoods - Pedestrian facilities within the downtown - Excellent local and regional transit connections - Commerical buildings oriented toward the sidewalk
Develop Interconnected Street Network Regular grid or other interconnected street system	Encourage multiple, narrow streets over isolated, hierarchical multi-lane arterials	- Pedestrian/bicycle connections - Short blocks
Provide Strategic Parking Facilities Provide less parking supply to reflect the increased transit use and walking/bicycling occurring as a result of implemented strategies. Management of parking should vary by land use type and proximity to transit service. Parking should facilitate, not inhibit, walking and transit	- Workplace parking managed at most locations - Supply does not exceed demand - On-street parking controlled - Parking shared among uses - Priority parking for bicycles, HOVs and ZEVs	- Pedestrian and bicycle facilities - Mixed uses within walking distance - Transit service (amount varies by situation)

(J/S1008/URBAN2.TK6)

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-3
URBAN AREA - LEVEL 3 SCENARIO

	Jurisdiction's Baseline Travel Characteristics[1]	PERFORMANCE GOALS LEVEL 3 (Medium Auto Travel)
VT/Household/Year	_____	2,200 to 2,600
VMT/Household/Year	_____	13,500 to 16,000
Auto Driver Mode Share of Person Trips	_____%	55%

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Neighborhood or District-Level		
Provide Pedestrian Facilities Pedestrian routes to encourage walking	Design features include: - crosswalks and pedestrian-actuated traffic signals - wide sidewalks (5-10 ft) - protection from fast vehicular traffic - reduced building setbacks - on-street entries to buildings	- Neighborhood services within ½ mile of most residences - Direct connections for pedestrians and bicycles - Integrated street pattern - Traffic calming measures
Increase Density Near Transit Corridors Compact residential and commercial uses within ¼ to ½ mile of major transit corridors	Residential density of at least 22 du/net residential acre or more, on average, and commercial intensity at minimum of 290 employees/net commercial acre, except theaters and hotels (FAR about 1.8)	- Pedestrian facilities - **15-min. transit headways** - Multiple bus routes - Integrated street pattern - New auto-oriented uses discouraged along corridor
Increase Density Near Transit Stations Compact residential and commercial uses within ¼ to ½ mile of stations	At least 40 du/net residential acre, on average. Commercial intensities at minimum of 330 employees/net commercial acre, except theaters and hotels (FAR about 2.0)	- Pedestrian facilities - **15-min transit headways** - New auto-oriented uses discouraged near stations

Notes: 1. Refer to baseline data described in Chapter 4 and Appendix E. These data should be specific to the jurisdiction if available.

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-3 (continued)
URBAN AREA - LEVEL 3 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Encourage Mixed-Use Development Mixed-use residential and commercial development the rule. Vertical and horizontal mixed-use, i.e., within and between buildings	Goals for larger sites; minimum % of gross floor area: Office center: - Office 35% - Retail 10% - Public 5% - Residential 10% Retail-cultural center: - Retail, hotel, entertainment 25% - Office 10% - Public 10% - Residential 10% Residential area: - Residential 40% - Retail/Office 10% - Public 10% Neighborhood center: - Residential 30% - Retail/Office 15% - Public 15%	- Pedestrian and bicycle facilities - Integrated street pattern
Community Level		
Encourage Infill and Densification Infill development to create clusters of higher residential density and to jobs-poor urbanized areas	Residential density at minimum of 18 du/net residential acre, on average.	- Pedestrian and bicycle facilities - Integrated street pattern - Employment centers and retail services near residential clusters - Transit service to residential clusters
Develop Concentrated Activity Centers (CACs) New primary employment directed at specified employment centers with functionally-integrated complementary uses, including residential	The number of CACs will vary with the size of the jurisdiction and metropolitan area	- Auto uses discouraged for internal circulation - Pedestrian facilities - Provision of services for employees - Transit service - Proximity to residential areas

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-3 (continued)
URBAN AREA - LEVEL 3 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Develop Interconnected Street Network Regular grid or other interconnected street system	Encourage multiple, narrow streets over isolated, hierarchical multi-lane arterials	- Pedestrian/bicycle connections - Short blocks
Provide Strategic Parking Facilities Provide less parking supply to reflect the increased transit use and walking/bicycling occurring as a result of implemented strategies. Management of parking should vary by land use type and proximity to transit service. Parking should facilitate, not inhibit, walking and transit	- Workplace parking managed at prime locations - Supply does not exceed demand - On-street parking controlled - Parking shared among uses - Priority parking for bicycles, HOVs and ZEVs	- Pedestrian and bicycle facilities - Mixed uses within walking distance - Transit service (amount varies by situation)
Strategy to Pursue If Progression to the Next Level is Desired		
Strengthen Downtowns A dominant city center or primary employment locale, with supporting housing, commercial, and region-serving public and cultural uses		- Direct pedestrian routes to surrounding neighborhoods - Pedestrian facilities within the downtown - Excellent local and regional transit connections - Commercial buildings oriented to the sidewalk

(J:\3100\URBAN3.TK6)

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-4
SUBURBAN AREA - LEVEL 1 SCENARIO

	Jurisdiction's Baseline Travel Characteristics[1]	PERFORMANCE GOALS LEVEL 1 (Very Low Auto Travel)
VT/Household/Year	_____	<3,200
VMT/Household/Year	_____	<20,000
Auto Driver Mode Share of Person Trips	_____%	60%

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Neighborhood or District-Level		
Provide Pedestrian Facilities Pedestrian routes to encourage walking	Design features include: - crosswalks and pedestrian-actuated traffic signals - wide sidewalks (5-10 ft) - protection from fast vehicular traffic - short block-faces - minimal building setbacks - on-street entries to buildings	- Neighborhood services within ½ mile of most residences - Direct connections for pedestrians and bicycles - Integrated street pattern - Routes that link compact, clustered development - Traffic calming measures
Increase Density Near Transit Corridors Compact residential and commercial uses within ¼ to ½ mile of major transit corridors	Residential density of at least 22 du/net residential acre or more, on average, and commercial intensity minimum of 260 employees/net commercial acre, except theaters, hotels, and motels (FAR about 1.6)	- Pedestrian facilities - 15-min. transit headways - Multiple bus routes - Integrated street pattern - New auto-oriented uses discouraged along corridor

Notes: 1. Refer to baseline data described in Chapter 4 and Appendix E. These data should be specific to the jurisdiction if available.

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-4 (continued)
SUBURBAN AREA - LEVEL 1 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Density Near Transit Stations Compact residential and commercial uses within ¼ to ½ mile of stations	At least 30 du/net residential acre, on average. Commercial intensities at minimum of 290 employees/net commercial acre, except theaters, hotels and motels (FAR about 1.8)	- Pedestrian facilities - **15-min transit headways** - New auto-oriented uses discouraged near stations
Encourage Mixed-Use Development Mixed-use residential and commercial development. Vertical and horizontal mixed uses, i.e., within and between buildings	Defined goals for larger sites; minimum % of gross floor area: Office center: - Office 30% - Retail 10% - Public 10% - Residential 10% Retail-cultural center: - Retail, hotel, entertainment 20% - Office 10% - Public 15% - Residential 10% Residential area: - Residential 40% - Retail/Office 10% - Public 10% Neighborhood center: - Residential 30% - Retail/Office 15% - Public 15%	- Pedestrian and bicycle facilities - Integrated street pattern
Community Level		
Encourage Infill and Densification Infill development to create clusters of higher residential density and to add employment to jobs-poor urbanized areas	Residential density at minimum of 16 du/net residential acre, on average.	- Pedestrian and bicycle facilities - Integrated street pattern - Employment centers and retail services near residential clusters - Transit service to residential clusters

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-4 (continued)
SUBURBAN AREA - LEVEL 1 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Develop Concentrated Activity Centers (CACs) Primary employment concentrated in a few carefully planned centers with functionally- integrated complementary uses, including residential	The number of CACs will vary with the size of the jurisdiction and metropolitan area	- Auto uses discouraged for internal circulation - Pedestrian facilities - Provision of services for employees - Transit service - Proximity to residential areas
Strengthen Downtowns A primary commercial area providing a range of goods and services to nearby communities as well as significant employment opportunities and public uses		- Direct pedestrian routes to surrounding neighborhoods - Pedestrian facilities within the downtown - Excellent local and regional transit connections - Commercial buildings oriented to the sidewalk
Develop Interconnected Street Network Regular grid or other interconnected street system	Encourage multiple, narrow streets over isolated, hierarchical multi-lane arterials	- Pedestrian/bicycle connections
Provide Strategic Parking Facilities Provide less parking supply to reflect the increased transit use and walking/bicycling occurring as a result of implemented strategies. Management of parking should vary by land use type and proximity to transit service. Parking should facilitate, not inhibit, walking and transit	- Workplace parking managed at most locations - Supply does not exceed demand - On-street parking controlled - Parking shared among uses - Priority parking for bicycles, HOVs and ZEVs	- Pedestrian and bicycle facilities - Mixed uses within walking distance - Transit service (amount varies by situation)

(J31006/SUBORB1.TK6)

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-5
SUBURBAN AREA - LEVEL 2 SCENARIO

	Jurisdiction's Baseline Travel Characteristics[1]	PERFORMANCE GOALS LEVEL 2 (Low Auto Travel)
VT/Household/Year	_____	3,200 to 3,500
VMT/Household/Year	_____	20,000 to 22,000
Auto Driver Mode Share of Person Trips	_____%	65%

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Neighborhood or District-Level		
Provide Pedestrian Facilities Pedestrian routes to encourage walking	Design features include: - crosswalks and pedestrian-actuated traffic signals - wide sidewalks (5-10 ft) - protection from fast vehicular traffic - short block-faces - minimal building setbacks - on-street entries to buildings	- Neighborhood services within ½ mile of most residences - Direct connections for pedestrians and bicycles - Integrated street pattern - Traffic calming measures
Increase Density Near Transit Corridors Compact residential and commercial uses within ¼ to ½ mile of major transit corridors	Residential density of at least 16 du/net residential acre or more, on average, and commercial intensity at minimum of 230 employees/net commercial acre, except theaters, hotels (FAR about 1.4)	- Pedestrian facilities - **20-min. transit headways in peak periods** - Multiple bus routes - Integrated street pattern - New auto-oriented uses discouraged along corridor

Notes: 1. Refer to baseline data described in Chapter 4 and Appendix E. These data should be specific to the jurisdiction if available.

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-5 (continued)
SUBURBAN AREA - LEVEL 2 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Encourage Mixed-Use Development Mixed use residential and commercial development. Vertical and horizontal mixed-use, i.e., within and between buildings	Goals for larger sites; minimum % of gross floor area: Office center: - Office 25% - Retail 10% - Public 10% - Residential 10% Retail-cultural center: - Retail 20% - Office 10% - Public 15% - Residential 10% Residential area: - Residential 40% - Retail/Office 10% - Public 10% Neighborhood center: - Residential 30% - Retail/Office 10% - Public 15%	- Pedestrian and bicycle facilities - Integrated street pattern
Community Level		
Encourage Infill and Densification Infill development to create clusters of higher residential density and to add employment to jobs-poor urbanized areas	Residential density at minimum of 12 du/net residential acre, on average.	- Pedestrian and bicycle facilities - Integrated street pattern - Employment centers and retail services near residential clusters - Transit service to residential clusters
Develop Concentrated Activity Centers (CACs) Primary employment concentrated in carefully planned centers with functionally-integrated complementary uses, including residential		- Auto uses discouraged for internal circulation - Pedestrian facilities - Provision of services for employees - Transit service - Proximity to residential areas

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-5 (continued)
SUBURBAN AREA - LEVEL 2 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Strengthen Downtowns A secondary commercial area providing a range of goods and services to the immediate community as well as some employment and public and cultural services		- Direct pedestrian routes to surrounding neighborhoods - Pedestrian facilities within the downtown - Transfer point for local and regional transit - Commercial buildings oriented to the sidewalk
Develop Interconnected Street Network Regular grid or other interconnected street system	Encourage multiple, narrow streets over isolated, hierarchical multi-lane arterials	- Pedestrian/bicycle connections
Provide Strategic Parking Facilities Provide less parking supply to reflect the increased transit use and walking/bicycling occurring as a result of implemented strategies. Management of parking should vary by land use type and proximity to transit service. Parking should facilitate, not inhibit, walking and transit	- Workplace parking managed at prime locations - Supply does not exceed demand - On-street parking controlled - Parking shared among uses - Priority parking for bicycles, HOVs and ZEVs	- Pedestrian and bicycle facilities - mixed uses within walking distance - Transit service (amount varies by situation)
Strategy to Pursue If Basic Infrastructure Exists		
Increase Density Near Transit Stations Compact residential and commercial uses within ¼ to ½ mile of stations	At least 20 du/net residential acre, on average. Commercial intensities at minimum of 260 employees/net commercial acre, except theaters, hotels, and motels (FAR about 1.6)	- Pedestrian facilities - 20-min transit headways - New auto-oriented uses discouraged near stations

(/31006/SUBURB2.TK6)

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-6
SUBURBAN AREA - LEVEL 3 SCENARIO

	Jurisdiction's Baseline Travel Characteristics[1]	PERFORMANCE GOALS LEVEL 3 (Medium Auto Travel)
VT/Household/Year	_____	3,600 to 4,000
VMT/Household/Year	_____	22,500 to 25,000
Auto Driver Mode Share of Person Trips	_____%	70%

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Neighborhood or District-Level		
Provide Pedestrian Facilities Pedestrian routes to encourage walking	Design features include: - crosswalks and pedestrian-actuated traffic signals - wide sidewalks (5 ft) - protection from fast vehicular traffic - minimal building setbacks - on-street entries to buildings	- Neighborhood services within ½ mile of most residences - Direct connections for pedestrians and bicycles - Integrated street pattern - Traffic calming measures
Increase Density Near Transit Corridors Compact residential and commercial uses within ¼ to ½ mile of major transit corridors	Residential density of at least 16 du/net residential acre, on average, and commercial intensity at minimum of 190 employees/net commercial acre, except theaters, hotels and motels (FAR about 1.2)	- Pedestrian facilities - Multiple bus routes - Integrated street pattern - New auto-oriented uses discouraged along corridor

Notes: 1. Refer to baseline data described in Chapter 4 and Appendix E. These data should be specific to the jurisdiction if available.

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-6 (continued)
SUBURBAN AREA - LEVEL 3 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Encourage Mixed-Use Development Mixed use residential and commercial development common. Vertical and horizontal mixed-use, i.e., within and between buildings.	Goals for larger sites; minimum % of gross floor area: Office center: - Office 20% - Retail 10% - Public 10% - Residential 15% Retail-cultural center: - Retail, motel, entertainment 10% - Office 10% - Public 15% - Residential 20% Residential area: - Residential 40% - Retail/Office 10% - Public 10% Neighborhood center: - Residential 30% - Retail/Office 10% - Public 10%	- Pedestrian and bicycle facilities - Integrated street pattern
Community Level		
Encourage Infill and Densification Infill development to create clusters of higher residential density and to add employment to jobs-poor urbanized areas	Residential density at minimum of 10 du/net residential acre, on average.	- Pedestrian and bicycle facilities - Integrated street pattern - Employment centers and retail services near residential clusters - Transit service to residential clusters
Develop Interconnected Street Network Regular grid or other interconnected street system	Encourage multiple, narrow streets over isolated, hierarchical multi-lane arterials	- Clear pedestrian/bicycle connections

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-6 (continued)
SUBURBAN AREA - LEVEL 3 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Strategies to Pursue if Progression to the Next Level is Desired		
Develop Concentrated Activity Centers Primary employment concentrated in carefully planned centers with functionally- integrated complementary uses, including residential.		- Auto uses discouraged for internal circulation - Pedestrian facilities - Provision of services for employees - Proximity to residential areas
Strengthen Downtowns A secondary commercial area providing a range of goods and services to the immediate community as well as some employment and public and cultural services.		- Direct pedestrian routes to surrounding neighborhoods - Pedestrian facilities within the downtown - Transfer point for local and regional transit - Commercial buildings oriented to the sidewalk
Strategy to Pursue if Basic Infrastructure Exists		
Increase Density Near Transit Stations Compact residential and commercial uses within ¼ to ½ mile of stations	At least 20 du/net residential acre, on average. Commercial intensities at minimum of 230 employees/net commercial acre, except theaters, hotels, and motels (FAR about 1.4)	- Pedestrian facilities - New auto-oriented uses discouraged near stations

(J31008/SUBURB3.TK6)

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-7
EXURBAN AREA - LEVEL 1 SCENARIO

	Jurisdiction's Baseline Travel Characteristics[1]	PERFORMANCE GOALS LEVEL 1
VT/Household/Year	_____	<4,500
VMT/Household/Year	_____	<28,000
Auto Driver Mode Share of Person Trips	_____%	65%

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Neighborhood or District-Level		
Provide Pedestrian Facilities Pedestrian routes to encourage walking	Design features include: - crosswalks and pedestrian-actuated traffic signals - wide sidewalks (5 ft) - protection from fast vehicular traffic - short block-faces - minimal building setbacks - on-street entries to buildings	- Neighborhood services within ½ mile of most residences - Direct connections for pedestrians and bicycles - Integrated street pattern - Traffic calming measures
Increase Density Near Transit Corridors Compact residential and commercial uses within ¼ to ½ mile of major transit corridors	Residential density of at least 10 du/net residential acre or more, on average, and commercial intensity at minimum of 160 employees/net commercial acre, except theaters and motels (FAR about 1.0)	- Pedestrian facilities - Multiple bus routes - Integrated street pattern - New auto-oriented uses discouraged along corridor

Notes: 1. Refer to baseline data described in Chapter 4 and Appendix E. These data should be specific to the jurisdiction if available.

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service

Table 6-7 (continued)
EXURBAN AREA - LEVEL 1 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Encourage Mixed-Use Development Mixed use residential and commercial development	Goals for larger sites; minimum % of gross floor area: Residential area: - Residential 40% - Retail/Office 10% - Public 10% Neighborhood center: - Residential 30% - Retail/Office 10% - Public 10%	- Pedestrian and bicycle facilities - Integrated street pattern
Community Level		
Encourage Infill and Densification Infill development to create clusters of higher residential density and to add employment to jobs-poor urbanized areas	Residential density at minimum of 8 or more du/net residential acre, on average.	- Pedestrian and bicycle facilities - Integrated street pattern - Employment centers and retail services near residential clusters - Transit service to residential clusters
Develop Concentrated Activity Centers Begin developing functionally-integrated complementary uses, including residential uses, around employment/activity centers.		- Auto uses discouraged for internal circulation - Pedestrian facilities - Provision of services for employees - Proximity to residential areas
Develop Interconnected Street Network Regular grid or other interconnected street system	Encourage multiple, narrow streets over isolated, hierarchical multi-lane arterials	- Clear pedestrian/bicycle connections
Provide Strategic Parking Facilities Provide less parking supply to reflect the increased transit use and walking/bicycling occurring as a result of implemented strategies. Management of parking should vary by land use type and proximity to transit service. Parking should facilitate, not inhibit, walking and transit	- Workplace parking managed at prime locations - Supply does not exceed demand - On-street parking controlled - Parking shared among uses - Priority parking for bicycles, HOVs and ZEVs	- Pedestrian and bicycle facilities - Mixed uses within walking distance - Transit service (amount varies by situation)

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service

Table 6-7 (continued)
EXURBAN AREA - LEVEL 1 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Strategies to Pursue If Basic Infrastructure Exists		
Increase Density Near Transit Stations Compact residential and commercial uses within ¼ to ½ mile of stations	At least 18 du/net residential acre, on average. Commercial intensities at minimum of 190 employees/net commercial acre, except theaters and motels (FAR about 1.2)	- Pedestrian facilities - New auto-oriented uses discouraged near stations
Strengthen Downtowns A secondary commercial area providing a range of goods and services to the immediate community as well as some employment and public and cultural services.		- Direct pedestrian routes to surrounding neighborhoods - Pedestrian facilities within the downtown - Transfer point for local and regional transit - Commercial buildings oriented to the sidewalk

(J:\1008\EXURBAN1.TK6)

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service

Table 6-8
EXURBAN AREA - LEVEL 2 SCENARIO

	Jurisdiction's Baseline Travel Characteristics[1]	PERFORMANCE GOALS LEVEL 2
VT/Household/Year	_____	4,500 to 4,800
VMT/Household/Year	_____	28,000 to 30,000
Auto Driver Mode Share of Person Trips	_____%	70%

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Neighborhood or District-Level		
Pedestrian Facilities Pedestrian routes to encourage walking	Design features include: - crosswalks and pedestrian-actuated traffic signals - wide sidewalks (5 ft) - protection from fast vehicular traffic - short block-faces - minimal building setbacks - on-street entries to buildings	- Neighborhood services within ½ mile of most residences - Direct connections for pedestrians and bicycles - Integrated street pattern
Encourage Mixed-Use Development Mixed use residential and commercial development	Goals for larger sites; minimum % of gross floor area: Residential area: - Residential 50% - Public 10% Neighborhood center: - Residential 30% - Retail/Office 10% - Public 10%	- Pedestrian and bicycle facilities - Integrated street pattern

Notes: 1. Refer to baseline data described in Chapter 4 and Appendix E. These data should be specific to the jurisdiction if available.

du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.

Table 6-8 (continued)
EXURBAN AREA - LEVEL 2 SCENARIO

RECOMMENDED STRATEGY PACKAGE		
STRATEGY DESCRIPTION	**STRATEGY CHARACTERISTICS**	**SUPPORTIVE FACTORS**
Community Level		
Encourage Infill and Densification Infill development to create clusters of higher residential density and to add employment to jobs-poor urbanized areas	Residential density at minimum of 7 du/net residential acre, on average.	- Pedestrian and bicycle facilities - Integrated street pattern - Employment centers and retail services near residential clusters - Transit service to residential clusters
Develop Interconnected Street Network Regular grid or other interconnected street system	Encourage multiple, narrow streets over isolated, hierarchical multi-lane arterials	- Clear pedestrian/bicycle connections
Strategy to Pursue If Progression to the Next Level is Desired		
Increase Density Near Transit Corridors Compact residential and commercial uses within ¼ to ½ mile of major transit corridors	Residential density of at least 10 du/net residential acre or more, on average, and commercial intensity at minimum of 130 employees/net commercial acre, except theaters and motels (FAR about 0.8)	- Pedestrian facilities - Multiple bus routes - Integrated street pattern - New auto-oriented uses discouraged along corridor
Strategies to Pursue If Basic Infrastructure Exists		
Increase Density Near Transit Stations Compact residential and commercial uses within ¼ to ½ mile of stations	At least 12 du/net residential acre, on average. Commercial intensities at minimum of 160 employees/net commercial acre, except theaters and motels (FAR about 1.0)	- Pedestrian facilities - New auto-oriented uses discouraged near stations
Strengthen Downtowns A secondary commercial area providing a range of goods and services to the immediate community as well as some employment and public and cultural services.		- Direct pedestrian routes to Surrounding neighborhoods - Pedestrian facilities within the downtown - Excellent local and regional transit connections - Commercial buildings oriented to the sidewalk

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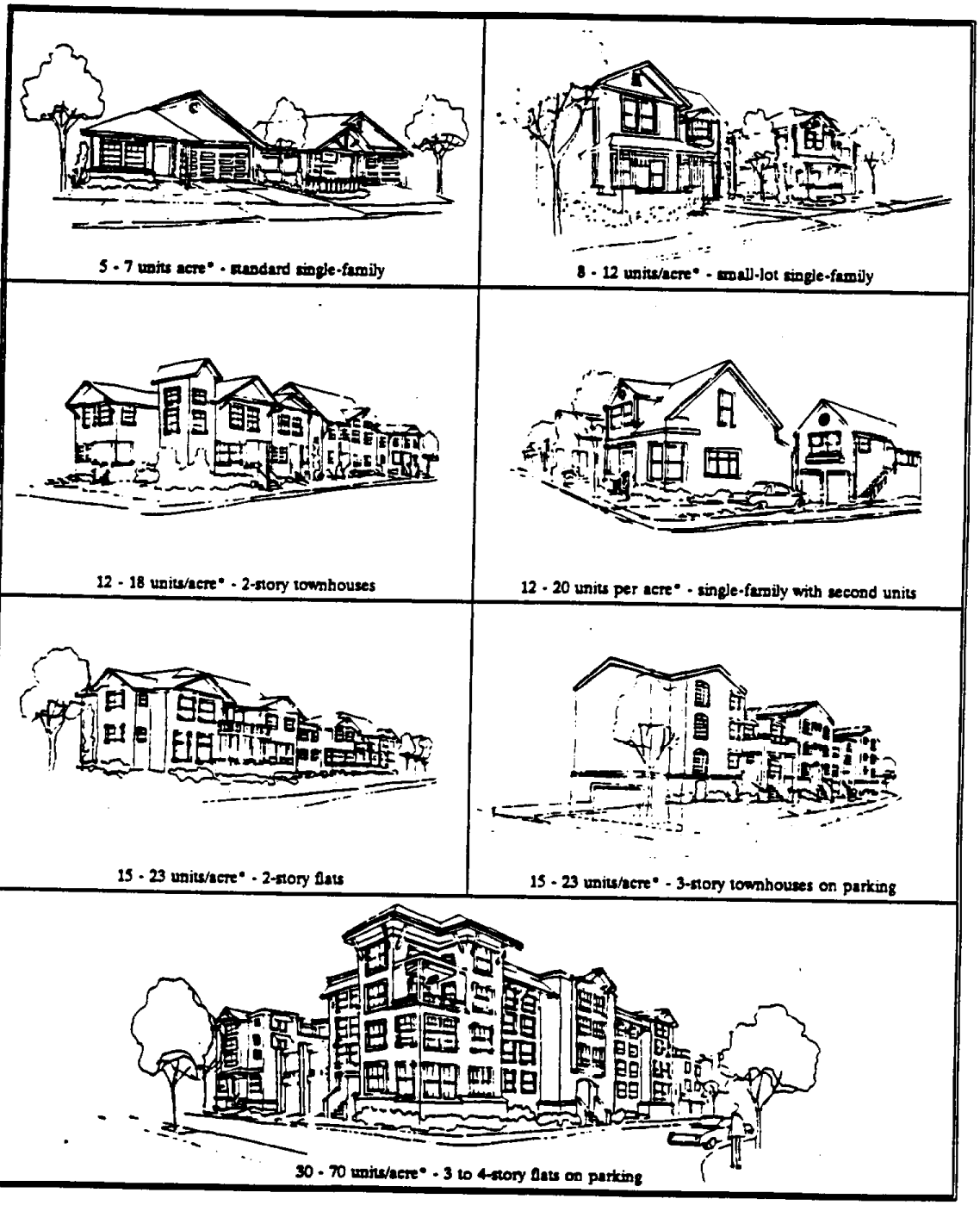
du - dwelling unit.
FAR - Floor Area Ratio: ratio of building floor area to area of lot.
net residential acre - residential area not including streets, open spaces, or commercial uses.
net commercial acre - commercial area not including streets, open spaces, or residential uses.
transit headway - frequency of transit service.



* Dwelling units per net residential acre: housing units per acre of land in residential use, not including streets and sidewalks.

Figure 6-1
Character of Residential Density

Table 6-9
EXAMPLES OF STRATEGY IMPLEMENTATION

STRATEGY	LAND USE TYPES	EXAMPLES OF LOCATIONS WHERE IMPLEMENTED
Provide Pedestrian Facilities	All land uses	San Francisco, Daly City, Torrance, Thousand Oaks, Chula Vista
Increase Density Near Transit Stations	Commercial and Retail Development, Residential, Public Uses, Light Industry, Schools, Hospitals, Restaurants	Portland, OR; San Francisco Bay Area; Vancouver, Canada; Los Angeles
Increase Density Near Transit Corridors	Commercial and Retail Development, Residential, Public Uses, Restaurants, Schools, Light Industry	Portland, OR; Richmond, Los Angeles
Encourage Mixed-Use Development	Commercial and Retail Development, Residential, Public Uses, Restaurants, Schools, Light Industry	San Francisco, Oakland, Daly City, Inglewood, Rancho Cucamonga (LA)
Encourage Infill and Densification	Commercial and Retail Development, Residential, Public Uses, Restaurants, Schools, Light Industry	Oakland, Daly City, Richmond, Mill Valley, Lancaster, San Luis Obispo
Develop Concentrated Activity Centers	Commercial and Retail Development, Residential, Restaurants, Public Uses, Light Industrial	Bellevue, WA; Tysons Corner, VA; Orange County, Santa Ana
Strengthen Downtowns	Commercial and Retail Development, Public Uses, Residential	San Francisco, Walnut Creek, El Monte, Pasadena, Pomona, Anaheim; Bellevue, WA; Portland, OR; Toronto, Canada
Develop Interconnected Street Networks	All land uses	San Francisco, Oakland, Daly City, Richmond, Mill Valley, Moreno Valley
Provide Strategic Parking Facilities	All land uses	San Francisco, Santa Ana; Portland, OR

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